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THE PASSING OF THE WHALE *

By FREDERIC A. LUCAS, Curator in Chief of the Museum of Arts and Sciences of the Brooklyn Institute.

WHALES as economic animals have been and continue to be of immense value to man. They are of the greatest possible interest zoologically, since they are the largest of existing animals. One species, the sulphur-bottom whale, attains a length of eighty feet, being of greater size than the extinct dinosaurus, the largest of the wonderful animals of the past.

From a strictly American viewpoint the whale deserves serious consideration, as it was half a century ago the basis of an industry which brought great wealth to the New England States. In the days when the whale fishery was most important there were over six hundred American ships and many thousands of men regularly engaged in that industry.

During a period of nearly fifty years prior to about 1872 the value of whale oil and whalebone landed by American vessels amounted to more than 270 millions of dollars. Subsequently the whaling industry as conducted from vessels gradually declined. The present method of whaling from shore stations is of quite recent introduction.

It is a startling fact that nearly all species of whales are threatened with early extinction by reason of the destructiveness of modern methods of whaling, practised chiefly from stations located on shore.

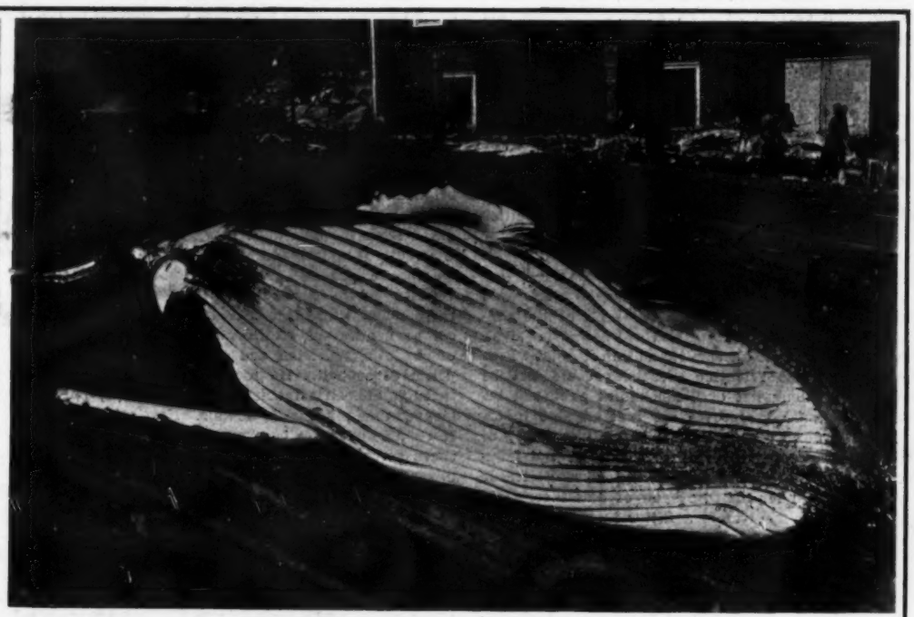
The protection of whales is therefore necessary if any whales are to be left for future supply. How rapidly whales of all kinds, save possibly the sperm whale, are disappearing before the attacks of man, may be inferred from a glance of the shore-whaling industry and particularly at that of Newfoundland, whose statistics are most readily available and where the effects of modern methods are most apparent.

Before 1903 we have no data as to the number of whales taken along the coast of Newfoundland and can only say that the value of whale products rose successively from $1,581 in 1898 to $36,428 in 1900 and $125,287 in 1902. Making a rough estimate, based on the value of the products of the whale fishery, one may say that this represents not less than 350 whales, more probably about 500, since prior to 1902 the waste was very great. The first whaling station in which modern methods were adopted was established in 1897 and its success was so great that in 1903 four others had been erected and three more planned, although but three steamers were then employed. R. T. McGrath in the Report of the Newfoundland Department of Fisheries for 1903, gave it as his opinion that no more applications for factories should be granted for some years to come, saying: "Two factories are about to be erected, one at Trinity and one at Bonavista,

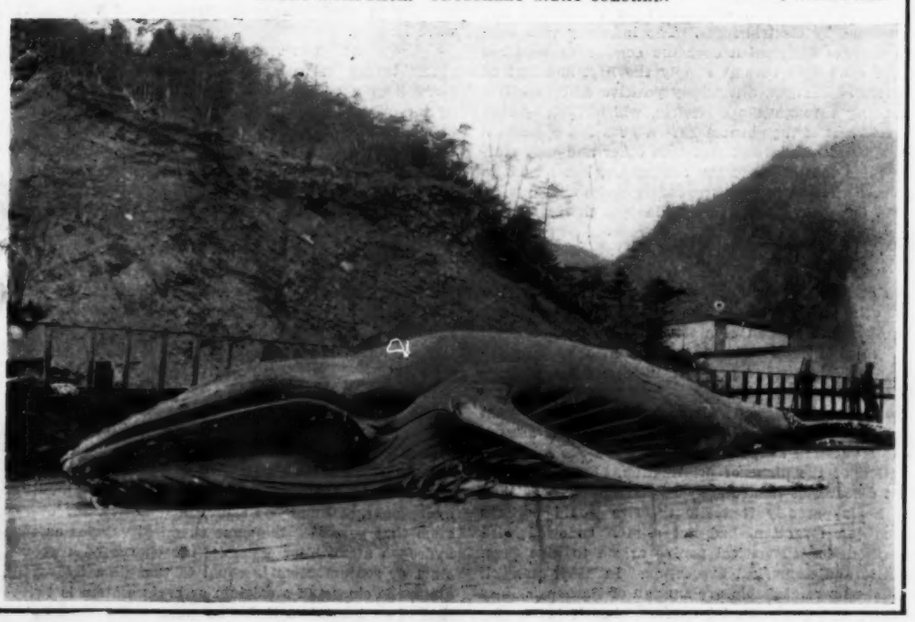
(*Concluded on page 344.*)

* New York Zoological Society Bulletin.

NORWEGIAN GUN-HARPOON EMPLOYED IN STEAM WHALING.



YOUNG HUMPBACK. UNUSUALLY LIGHT COLORED. Photo by William Palmer



HUMPBACK WHALE. OLD FEMALE. Photo by William Palmer.

THE PASSING OF THE WHALE.

A HISTORY OF ELECTRICAL THEORIES.

THE CHANGES WHICH DISCOVERY HAVE WROUGHT.

BY P. GRUNER, PROFESSOR OF THEORETICAL PHYSICS IN THE UNIVERSITY OF BERNE.

THE Greek philosophers who were familiar with the fact that amber, or elektron, which had been rubbed with a cloth attracted bits of parchment, gave their fancy free rein in seeking the cause of this singular phenomenon. Their naïve conceptions of the nature of electricity lie buried beneath the dust of ages, and it was not until the second half of the sixteenth century that the attention of scientific men was directed to frictional electricity, by Gilbert, who discerned its relation to the phenomena of thunder storms.

I. THE THEORY OF ACTION AT A DISTANCE.

This theory was taught in colleges until twenty years ago. The reign of theories of action at a distance in science was inaugurated by the discoveries of Newton. The notion of the mutual action between two bodies was extended beyond ordinary matter and applied to two imponderable fluids, positive and negative, which could combine to form a neutral fluid, and which, by their interaction, caused the attractions and repulsions of electrified bodies. In 1789, Galvani discovered the electrical contraction of the muscle of a frog's leg, and thereafter electrical science made rapid progress. Volta invented the voltaic pile in 1799, Davy produced the electric arc a few years later, Oersted discovered the deviation of a magnetized needle by a current in 1820, Ampère published his classical theory of electro-magnetism in 1827, and in the same year Faraday discovered the induction of currents.

The explanation of these varied phenomena by means of two electrical fluids and action at a distance occupied the attention of the most eminent physicists of the nineteenth century. The last word was said in 1846 by W. Weber, according to whose theory the electrical fluids, as they flow through conductors, exert on each other forces which depend on their velocities and accelerations, as well as on the inverse square of the distance.

II. THE ELECTROMAGNETIC THEORY OF LIGHT.

Yet beneath this predominant current of scientific thought flowed a hidden current which at the predestined moment burst forth and overflowed its rival. Faraday was at once an empiric and an idealist whose confidence in his scientific principles could not be shaken. The long list of his memoirs published between 1832 and 1855 proves his indefatigable industry. He could never accept the prevailing theory of action at a distance, and his discovery of the influence of the dielectric on the charge of a condenser was his fulcrum for the overthrow of that theory. If the intervening medium is a factor in producing the phenomena it becomes absurd to speak of direct action between the two electric charges. On the other hand, his discovery that electric force cannot penetrate into the interior of a hollow conductor suggested a paradoxical interpretation of the functions of conductors and insulators. Insulators were defined as substances permeable, conductors as substances not permeable, by electric force. The infinitely thin electric charges distributed over the conducting surfaces of the condenser became simply the first and last of a series of charges, alternately positive and negative, extending through the dielectric, which thus became the real seat of the phenomena. We see two oppositely electrified conductors attract each other and we naturally refer the action to the conductors, but a change has been effected in the surrounding space and an electrified pith ball, suspended anywhere in the room, will indicate by its movement the existence of an electrical force and show the magnitude and direction of the force at that point. Hence arose the conception of lines of force, which Faraday regarded as the expression of a physical fact—a tension of the ether which resembles the tension of a stretched elastic substance and which, in dielectrics, is accompanied by a polarization which finds expression in molecular positive and negative charges.

Would not this electrical tension modify the optical properties of the ether? Faraday sought an answer to this question and, in 1846, discovered the magnetic rotation of the plane of polarization. Faraday's brilliant discoveries immediately received due recognition, but his apparently fantastic theories would perhaps have been forgotten, had not a man endowed with exceptional mathematical genius arisen to give them definite and numerical expression. In 1855, Maxwell published a remarkable explanation of Faraday's lines of force and, ten years later, made himself famous by his noble electromagnetic theory of light, a work of great complexity and not free from inconsistencies, but still a work of genius. On Maxwell's theory, electric forces are propagated through space and through dielectrics with very great, but finite, velocities, which are approximately equal to the velocities of light in similar conditions. Hence there is no action at a distance, and electrical quantity becomes a mere mathematical expression. In space the velocity is equal to the ratio between the electrostatic and electromagnetic units of electricity, and in a dielectric medium it is inversely proportional to the square of the specific inductive capacity, or dielectric constant. Now, the refractive indices of certain dielectrics had already been found approximately equal to the square roots of the dielectric constants, and the ratio of the units was found to be about 300,000 kilometers (186,000 miles) per second, or very nearly the same as the velocity of light.

Twenty years later, in 1887, Hertz published the results of his experiments with very rapid electrical oscillations. It was already known that electrical oscillations are produced by the discharge of a Leyden jar and in the operation of a powerful induction coil, and that these oscillations, which are perfectly explained by the old theory of electricity, induce alternating currents in neighboring metallic circuits, and sparks at gaps in such circuits. There was nothing absolutely new in these first experiments of Hertz, but thenceforth he possessed an instrument which enabled him to determine whether electric force is propagated instantaneously or not. In the same year, 1887, Hertz placed a large metal mirror before his oscillator and explored the intervening space with his resonator or wave detector. The result confirmed Maxwell's theory. A system of stationary interferences was established, the spark of the resonator was brightest in the ventral segments and vanished at the nodes, and the velocity of the electric waves, as deduced from the half wave length, or distance between consecutive nodes, combined with the known frequency of the oscillator, was found equal to the velocity of light. Subsequently Hertz succeeded in reproducing with his electric waves the cardinal optical phenomena of rectilinear propagation, formation of shadows, reflection and even refraction by a huge prism of asphalt. He found that the waves passed through dielectric media, doors and walls, but were stopped and reflected by metals. Now, when powerful Hertzian waves are employed to convey wireless messages across the ocean, the significance of the Faraday-Maxwell-Hertz theory becomes evident even to the uninitiated. The idea of the nature of electricity which is involved in this theory may be expressed by saying that electricity is a peculiar condition of the omnipresent ether, that this condition is manifested by electromagnetic forces which, as waves, are propagated with very great velocities through the ether and through dielectric media, but are reflected from the surface of conductors, and, finally, that light consists of electromagnetic vibrations of very short wave lengths.

III. THE THEORY OF ELECTRONS.

The theory of action at a distance prevailed for more than a century and was very slowly displaced by the electro-magnetic theory of light, but now, only twenty years after the discoveries of Hertz, a third theory of the nature of electricity is acquiring predominance. It is a remarkable fact that the name of Faraday is associated with the new theory as it was with its predecessor, and that the triad Faraday-Maxwell-Hertz has simply been replaced by the triad Faraday-Lorentz-Zeeman. For the new theory is based on Faraday's law of electrolysis. It is equally remarkable that in the year 1896, in which Marconi popularized the ideas of Hertz, the foundations of the new theory were laid by Zeeman's discovery of the magnetic displacement of spectral lines and Becquerel's discovery of radioactivity.

When an electric current passes through acidulated water the water is decomposed into hydrogen and oxygen, which are evolved in gaseous form at the electrodes. This phenomenon is called electrolysis. The hydrogen atom carries with it an electric charge which is the same, in nature and amount, for every hydrogen atom, and the same, in quantity, for every atom that possesses the same chemical valence as the hydrogen atom. For example, the charge of a potassium or sodium atom is equal to that of a hydrogen atom, the charge of a calcium or barium atom is twice that of an iron atom thrice as great.

It is natural, therefore, to attribute a physical existence to this unvarying electric charge of a monovalent atom and to regard it as the indivisible element, or atom, of electricity. This conception again changes the definition of electricity. After we have, with great difficulty, substituted a peculiar condition of the ether for the old imponderable fluids, we discover that electricity is composed of very small particles, analogous to material atoms. These particles are called electrons. The electric charge of the electron had been measured and found to be 3×10^{-10} electrostatic units, and its mass has been determined to be about 2,000 times smaller than that of an atom of hydrogen.

The attainment of these surprising results was made possible by the discovery of various remarkable phenomena. In 1876, Sir William Crookes published his researches on the electric discharge in rarefied gases. From certain unexpected phenomena of fluorescence, the production of heat, and the formation of electric shadows by screens, Crookes concluded that very small particles were projected with exceeding swiftness from the cathode of the exhausted tube, but his ideas were not accepted until they were confirmed, twenty years later, by the astounding discoveries of Roentgen and Curie. Now it has been proved that the cathode rays consist of electrified particles, identical with the negative electrons of electrolysis, projected with a speed which is almost inconceivable but yet can be measured by means of the deviation of the rays by a magnet. In the field of radioactivity the names of Curie, Rutherford, and Ramsay are pre-eminent.

A new theory needs a pioneer who will pursue his way with little regard to contemporary opinion. Almost forty years ago, when Maxwell's theory was slowly gaining adherents, A. H. Lorentz, at Leyden, was beginning to form a new theory of the nature of electricity, which he subsequently continued to develop and which he published, in exemplary mathematical form, between 1892 and 1895. The theory of Lorentz, however, is rather a transformation than a contradiction of Maxwell's. It admits the truth of the Maxwell-Hertz equations governing the propagation of electromagnetic forces through the ether, but it assumes the existence of electric centers, or electrons, which neutralize each other by combination and produce the electromagnetic effects by their motions, when they are free.

Faraday sought in vain to discover some effect produced by a magnet on the luminous spectrum. In 1896, Zeeman renewed the search with the aid of modern experimental resources. He found that when a sodium flame was placed between the poles of an electromagnet each of the two yellow lines which compose the spectrum split into two or three lines, according to the direction of the magnetic field. This result is a necessary consequence of the theory of Lorentz, but it cannot be explained by either of the older theories.

From the displacement of the lines Lorentz deduced values of the mass and the electric charge of the electron which agree closely with the values obtained from cathode rays. These experiments awakened a lively interest in the electronic theory, the consequences of which have been developed by several physicists. The electric current is conceived as a stream of swiftly moving electrons retarded by the molecules of the conductor. Relations between thermal and electric conductivity, between conductivity and magnetic effects, and between thermo-electric currents and the electricity of contact have been deduced from the theory and verified by experiment.

The molecular currents of Ampere's theory of magnetism are also in perfect accordance with the theory of electrons. The Zeeman effect and many other optical phenomena are explained as consequences of the oscillation of electrons.

In every case it is the negative electron which explains the phenomenon and wherever positive electrons are involved it cannot be determined whether these electrons are free or attached to material atoms. This suggests a resemblance to the old single fluid theory of electricity.

The following, therefore, are the main points of the new theory. All electrical phenomena are due to the existence of minute electrical particles, or electrons; only the negative electron is known to exist in a free state; the mass of the negative electron is about 2,000 times smaller than the mass of the hydrogen atom; electromagnetic forces are caused by the motion of electrons and are propagated with the velocity of light; the electric or magnetic state of a body cannot be

altered except by the movement of electrons; electric currents are streams of moving electrons; magnetism is caused by revolving electrons, luminous and electromagnetic waves by oscillating electrons; peculiar rays (cathode and X-rays) consist of electrons moving at great velocities, unhampered by material atoms.

IV. CONCLUSIONS.

It appears from this discussion that recent progress in electrical theory has been, in many respects, retrograde, and we may well wonder what direction its development will take in the future. Two elements of uncertainty deserve special mention.

In the theory of Lorentz, the ether is assumed to be absolutely motionless, while electrons and atoms are free to move. Now, as every movement of an electron develops an electromagnetic field, the motions of the earth and the sun must give rise to terrestrial electromagnetic disturbances. Lorentz has demonstrated that in certain very special conditions these disturbances should be perceptible, but experiments of great delicacy have failed to detect them. Hypotheses have been advanced to explain this discrepancy but the problem, in all probability, will long remain unsolved.

The second uncertainty attaches to the mass of the electron. Its effective mass is found to depend on its velocity—an apparent paradox, for invariability seems a necessary property of mass. But the electronic theory, particularly in the form which Abraham has given it, leads inevitably to the conclusion that the mass of the electron consists entirely of energy. Hence the mass is fictitious, and the electron is an immaterial point attached by indestructible bonds to the electromagnetic field. But the electromagnetic field is an electrical phenomenon, hence we are explaining electricity by means of electricity. Again, if the atoms of all matter are composed of electrons, and these are only centers of force, the entire universe is immaterial. Nothing is left except electricity, and to the question: "What is electricity?" we can give no answer.—Abridgment of a paper read before the Keplerbund at Frankfort.

REBUILDING THE PARIS TELEPHONE SYSTEM.

A RECORD-BREAKING PERFORMANCE.

BY S. E. BROWN.

COMMERCIALLY speechless—such was practically the condition in which thousands of business men of Paris found themselves on the morning of September 21, 1908. Berlin, which the day before was at their elbows, now lay to the northward distant six hundred miles; London, only a moment's time away twelve hours before, was now across the sea; and the provinces of France, which had lain within the shadow of the walls of the capital, now stretched from Alsace-Lorraine to the Pyrenees.

The burning of a single building in Paris—the great Central Telephone Exchange—was what isolated and paralyzed her commercially. A fire of a few hours' duration ate up much valuable property, took the business district out of a single structure, spread it over a wide area, and pushed the city back in history more than twenty years.

Rob any modern city of its telephone system, and it goes back to where it stood before the telephone became a commercial necessity. But what makes the modern city helpless when its telephone equipment is destroyed, is that it cannot go back. The reason for this is that the telephone made the modern city possible. Try to imagine New York's skyscraper district without the telephone!

Business for one day in Paris was carried on by means of what telegraph lines had not been ruined when the telephone building burned, by messenger service, by special conveyance, by every method possible that would give a greater speed than mail. The next day saw an emergency telephone equipment carling for crippled business as best it could. Meanwhile hurried conferences were being held by the Paris telephone managers with the Paris representatives of an American manufacturing company relative to an equipment to take the place of that destroyed; for emergency equipments at best are but first aids to the wounded, and are to be put aside as speedily as possible.

The building of equipment for a telephone exchange the size of the one destroyed requires time, and the people of Paris were clamoring for telephone service. This explains why the managers of the Paris Telephone Company immediately after the fire took their problem up with the largest manufacturers of telephone apparatus in the world. Speed was the controlling factor; speed and quality. So they turned to a company that held the record for both.

The task assigned to the Paris house of the company in question was staggering.

When the request from Paris was telegraphed to the United States, the men in charge of the telephone manufacture figured coolly and swiftly. They knew what they had done in similar cases could be done again. September 22 Paris had the cabled reply that the Americans could furnish their part of the equipment complete in less than thirty days.

A diversion was created on the 24th by Paris asking for switchboard cable—a request which terminated a few days later in an order for 135,000 feet. The full amount of the size desired was in stock. Shipping cable by steamer differs from shipment by rail. The cable must be fully protected from salt water. Nevertheless, the 25 miles of cable was unwound from reels, the ends paraffined, the cable rewound on reels, packed in waterproof cases, and placed on cars in less than two days after receiving the order.

On September 29 the New York house gave orders to begin work on a switchboard, and stated that the Paris house had agreed to have the entire installation completed in sixty days and that a $600 daily penalty was attached to the contract.

Men trained to the minute in switchboard building began their tasks. In a trifle over three weeks after a definite order had been given by the managers of the telephone exchange in Paris, the finished switchboard was ready for shipment.

Reservation was made on a French Line steamer that sailed on October 29, and arrangements were made with railroads that special attention be given the shipment. It was. The six carloads of material came 1,000 miles to New York in about two days.

The shipment together with a large amount of additional material which the New York house had manufactured was sent to Paris on the French Line steamer "La Provence," that sailed from New York on October 29. Thus only a few days more than a month elapsed from the date the fire occurred in Paris until a complete switchboard from the United States was on the sea; a switchboard, by the way, which stands 180 feet long, requires 90 operators to operate, and will accommodate more than 10,000 subscribers. While the back of this switchboard would appear as unintelligible to the layman as a page of Sanskrit, it may be of interest to know that it contains about a million soldered connections and 3,000 miles of wire. It is of some interest also to know that approximately 40,000 feet of lumber were used in packing the completed board, and that 10,000 square feet of paraffine paper was used in the cabling boxes alone.

EXPERIMENTS ON THE CONSTITUTION OF THE ELECTRIC SPARK.

By photographing on a rapidly-moving photographic film the spectrum of the ordinary oscillatory spark with small self-induction, T. Royds has obtained some valuable results. The method has now been applied to study the spark when the self-induction of the circuit is gradually increased. On account of the feebleness of the light in these cases it has been found necessary to remove the prisms, photographing directly the image of the slit, in order to avoid the loss of light due to dispersion by the prism. It is still possible under these conditions to differentiate by their character the streamers in the metallic vapor from those in the air. Condensers, whose capacity amounted to about one-third of a microfarad, were charged from a large Wimshurst machine and the spark of 8 millimeters length passed between metal electrodes. Self-inductances, ranging in value up to 0.026 henry, could be inserted in the circuit. The velocity of the photographic film was about 100 meters per second. The commencement of the spark is marked by a sudden and almost instantaneous luminosity of the air, showing on the photographs as a narrow vertical line. The duration of the luminosity is not appreciably affected even when the period of the circuit reaches a value of about 2×10^{-4} seconds. This initial air discharge does not start quite simultaneously at all parts of the spark length. It is followed by another type of streamers through the air in which the duration is comparable with the interval between the oscillations; in some cases the oscillation is divided into more than one air streamer. After the initial air discharge has passed, the light from the spark is chiefly due to the metallic vapor which is produced. The moment of vaporization of the metal is simultaneous with the passage of the initial air discharge. The first streamer in the metallic vapor often reaches to the center of the spark. The slope of this streamer gives the velocity with which the vapor first produced is moving along the line joining the two electrodes. The luminosity of the metallic vapor afterward consists of streamers starting from the electrodes. At the instantaneously positive electrode the luminosity of the streamers is of longer duration than at the negative; the streamers are not so numerous nor so distinct. There is not, however, the marked difference in the intensity of the streamers at the instantaneously positive and negative electrodes which was noticed in a previous paper on the spark with small self-induction. It is again found, however, that at the commencement of the spark, vapor is produced at both the positive and negative electrodes. Dark spaces at the electrodes separate the oscillations of the circuit and serve to measure the period of the oscillations.

The Velocity of the Metallic Vapor.—The measurements of the photographs show that the velocity of the metallic vapor first produced is smaller in the spark with self-induction than in the ordinary spark. In the case of mercury, for example, the velocity becomes 620 meters per second; the velocities found in the ordinary spark are 1,150 and 940 meters per second, for two different types of spectral lines. This is more probably due to a reduced temperature rather than to the supposition that the quantity of metal vaporized is not sufficient in the former case to produce the difference of pressure required to make the velocity of diffusion attain its maximum value. The introduction of self-induction brings out the "arc" lines of the metal. The evidence now obtained that the arc lines are due to, or accompanied by, a lower temperature confirms Lockyer's supposition which forms the basis of his researches on star temperatures. When the self-inductance of the spark is increased, it is seen that during a single oscillation several streamers start from the electrodes; they are more distinct with magnesium than with lead, bismuth, or mercury. The streamers are too numerous and close together to make useful the supposition that they are due to harmonic overtones of the fundamental period of the circuit. The streamers are found to recur at definite intervals after the commencement of each oscillation of the spark, though they are not invariably present in every oscillation; generally not more than about ten appear in a single complete oscillation. These intervals are the same in different photographs of the spark under the same conditions; but the individual streamers are not always reproduced in the same oscillation in different photographs.

THE WORLD'S WINE CROP.

CONSUL JAMES E. DUNNING, of Milan, in a statement dated April 7, 1908, gives out the figures on the world's wine crop for last year as compiled by the Italian trade, thus:

Country.	Gallons.
United States	40,000,000
Italy	1,495,126,400
France	1,744,255,207
Germany	50,160,000
Austria	92,400,000
Hungary	81,400,000
Spain	464,640,000
Portugal	118,800,000
Switzerland	23,760,000
Russia	68,640,000
Mexico	500,000
Argentina	35,000,000
Chile	55,000,000
Brazil	8,000,000
Bolivia	650,000
Cape Colony	5,000,000
Corsica	6,654,800
Algeria	227,072,400
Tunis	7,920,000
Azores, Canaries, and Madeira	3,960,000
Luxemburg	2,772,000
Turkey*	39,600,000
Greece	32,000,000
Bulgaria	50,000,000
Servia	10,000,000
Roumania	68,740,000
Persia	450,000
Peru	2,400,000
Uruguay	2,300,000
Australia	7,000,000
Total	4,744,200,807

The Italian crop for 1906 was 786,288,880 gallons.

* Including Cyprus.

STAMP-VENDING MACHINES.*

THE CONSTRUCTION OF AN AUTOMATIC GERMAN DEVICE.

BY OUR BERLIN CORRESPONDENT.

WITH a view to affording the public a more convenient means of obtaining postage stamps, the German Postal Department has for the past twenty years been engaged in seeking a suitable machine for automatically vending stamps. A few years ago, Mr. W. Abel of Berlin, in conjunction with Mr. H. Wollheim, succeeded in developing a very efficient apparatus of this kind, of which a description is given below.

At the very outset, the machine was found available for public use, and several were installed outside of the Berlin post office, but the latest type of apparatus, which has just been brought out, has given such excellent results that the German postal authorities intend installing it on a large scale throughout the country.

A special feature of this apparatus is that the stamps form a continuous tape, which is sufficient for from five hundred to a thousand sales. The apparatus was designed both for hand and for motor operation. The type adopted by the German postal authorities is entirely automatic, dispensing with any manipulation on the part of the purchaser, apart from the inserting of the coin.

The accompanying line cuts show the details of the hand-operated stamp-vending machine. Fig. 1 of the drawings represents the automatic vender as viewed from one side, Fig. 2 from the opposite side, Fig. 3 in plan, Fig. 4 in end elevation, and Fig. 5 shows a detail of the separating mechanism. The operating slide *a*, provided with the handle *a'*, is arranged in parallel with the direction in which the strip of stamps *l* is fed. The coiled strip or band of stamps is inclosed in a casing *b*. The strip, on issuing from the casing, passes between the guides *c* to the feeding mechanism *d*. The latter is connected to the slide *a* by means of a lever *e* in such a way that on moving the lever in the direction of the arrow *I* (Fig. 3), the feed mechanism *d* is moved in the direction of the arrow *II*; while upon the return of the slide, the motion of the feed device is reversed. The feed mechanism comprises a series of pawls or pins, 5, pivoted on a shaft, 6. The latter is journaled in a U-shaped lever, 7, fulcrumed to the frame at the bottom of the machine. This U-shaped lever is connected to the lever *e* by means of a coupling, 9. When the operating slide *a* is drawn up, the U-shaped lever 7 is swung backward, dragging the pawls 5 over the strip of stamps; but when the operating slide is released, the spring *I* returns it to its original position and, by means of the lever *e*, causes the series of pawls 5 to move forward. These engaging the perforations of the strip of stamps, serve to push the stamps forward under the separating mechanism *F* a distance equal to the length of one stamp. Fig. 3 shows in broken lines the strip of stamps moved forward ready for severing.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

By referring to Fig. 2, it will be observed that the operating lever *a* is formed with a depending lug 14, adapted to engage a roller 15 on the arm 16. The latter is mounted to oscillate on the shaft 17, and carries a pawl 18, adapted to engage the teeth of a ratchet wheel 19. This wheel is keyed to the cam wheel 20. A lever, 3 (Fig. 4), journaled at right angles to the axis of the cam wheel, carries a roller, 21, adapted to bear on the periphery of the cam wheel. The opposite end of the lever 3 is connected by a spring to a yoke piece, 25, which is mounted to swing on the shaft 23. This yoke piece is provided with bearing surfaces 30, adapted to clamp the stamp strip against similar bearing surfaces 31 at either side of the point of severance. The yoke piece 25 is moved into engagement with the stamp strip by the action of the lever 3, operating through a spring 35. After the stamp strip has been firmly clamped by the yoke piece 35, a roller 38 on the lever 3 strikes the severing tool 32, causing the latter to descend and separate the stamp from the rest of the strip. The separating tool is preferably blunt, so that it will not cut the stamp, but will tear it apart from the main strip.

The operating slide *a* is normally locked by means of a lever 49 hinged at the forward end 50, and provided at the opposite end 51 with depending ears which saddle the slide. The end of the lever bears against an abutment 52 in the slide, preventing the latter from being drawn out. To operate the machine, a coin must be inserted in the slot 48, whence it drops into a slot in the slide *a*, and acts like a wedge to lift the lever 49 clear of the abutment 52, permitting the slide to be drawn out. The operation will be understood on studying Fig. 2. When the slide is drawn out, it carries the coin clear of the support 46, and permits it to drop into the chute 53, and thence to the coin bag. Above the slide *a* is a pawl *g*, which bears against a serrated surface on the upper face of the slide *a*. This pawl prevents the slide from returning to its normal position until it has been drawn out its full length, after which the pawl *g* swings clear of the end of the slide, and permits the latter to spring back to its original position.

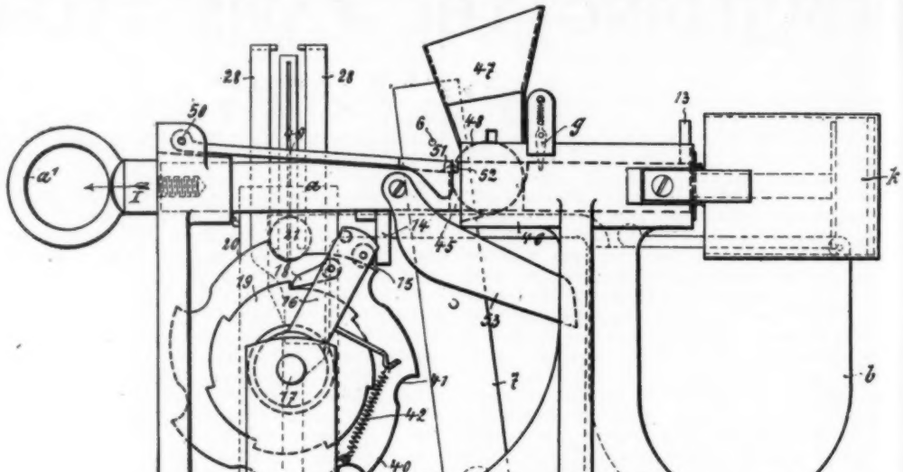


FIG. 2.—SECTIONAL VIEW, SHOWING RIGHT-HAND SIDE.

In order to stop the operation of the machine when the strip of stamps is exhausted, a lever 58 is provided, hinged at 59. One end of this lever bears lightly against the upper surface of the strip of stamps. When this strip has been exhausted, the lever falls, bringing its opposite end into engagement with a catch 61, which either prevents the coin from dropping out of the slide *a*, or else turns the coin chute to such a position that it will return the coin to the operator.

The motor-operated apparatus is quite similar to the machine just described, except that the parts are actuated by the motor, and the purchaser has only to insert the coin in the slot. The machine is fully protected against any atmospheric influences, and will operate perfectly in any weather.

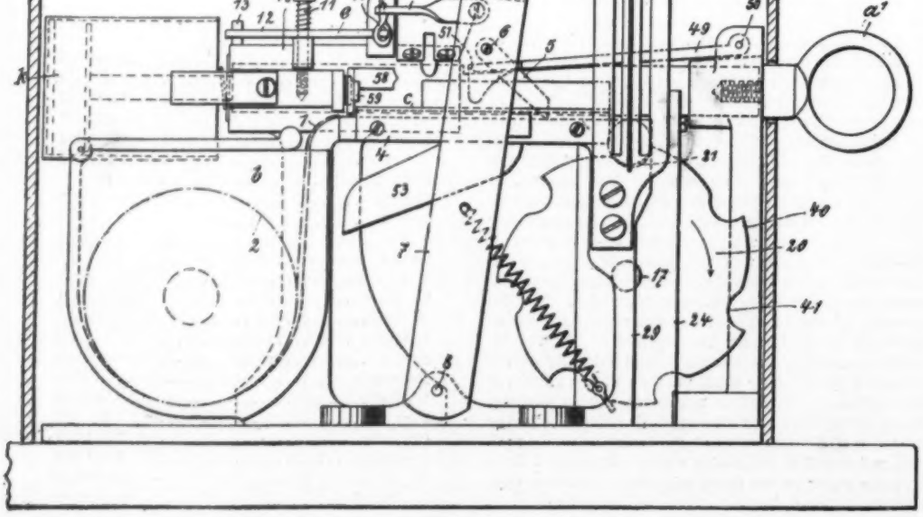


FIG. 1.—SECTIONAL VIEW, SHOWING LEFT-HAND SIDE.

THE PROBLEM OF GAS PROPULSION.

THE performance of the old gunboat "Rattler," which has lately attracted so much attention by reason of her system of propulsion with suction gas engines in place of her original steam machinery, provides considerable food for thought and speculation as to the lines on which gas-driven vessels will develop. That gas power will eventually become a definite integral part of marine engineering no one, except possibly the most hardened cynic, doubts. The one fact that the gas engine has an economy which the steam engine, after nearly a century's improvement, cannot hope to realize is sufficient warrant for this assumption without reference to the other apparent advantages, such as reduction of space, weight, and quantity of fuel carried, all of which are of the utmost importance in ship design. But in painting these advantages in glowing colors the enthusiast is apt to lose sight of, or, at least, to slur over the limitations of the gas engine and producer as at present constructed, and by so doing renders a disservice to the cause of progress. While we may be quite certain that gas power will play an important part in marine engine development, we may be equally certain that the process will be slow and tedious. Evolution and not revolution is the keynote of this as of most other engineering problems, and the idea of very large war

or merchant ships propelled by internal combustion engines of many thousand horse-power as an immediate possibility is a dream and nothing more.

In power installations ashore the demand for larger units is progressing at a greater rate than the present rate of increase of size in gas engines, and the

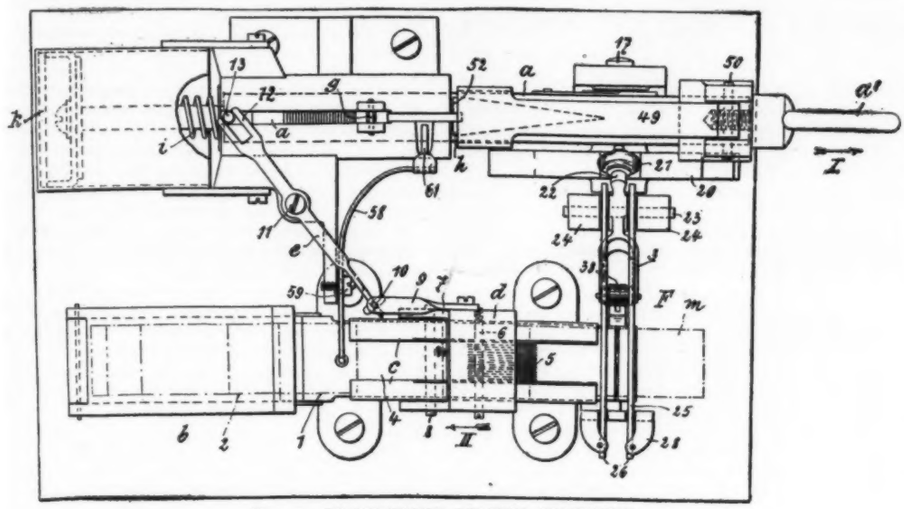


FIG. 3.—PLAN VIEW OF THE MACHINE.

latter is making a gallant but essentially a stern chase after its rival. At sea the demand for higher powers is increasing still more rapidly. The adaptation of the gas engine to marine work is scarcely begun, and while the successive increases in size in steam machinery is rendered comparatively easy by reason of accumulated experience, in the case of the gas engine a number of formidable difficulties have to be faced without any guidance from the past. These difficulties may be classified under two heads, mechanical and thermal, and they may overlap and react one on the other. As regards the mechanical features, a first essential is that the engine must be reversible, and capable of being stopped easily and started in either direction with a facility comparable to that of our present marine steam engines. So long as the powers are small, reversing by means of a reversing propeller or clutch and gearing can be accepted as a compromise, but this evasion of the problem becomes impracticable at such moderate outputs as, say, three or four hundred horse-power. It may be that the solution of the problem of a reversing engine is not so very difficult, but so far as we are aware the largest size of marine engine which has satisfactorily been made reversible is of 80 B.H.P., and though it is quite possible that an extension to higher powers could be made, much experiment in detail and extended trial at sea to secure and to demonstrate reliability in working would undoubtedly be necessary. Another mechanical problem is to be found in the type of engine. The vertical gas engine on shore has presented many difficulties, some anticipated and some unexpected, which only now we are beginning to understand and overcome; and while this type is to be preferred where space is a consideration, it is generally thought that on shore the horizontal type, while avoiding the peculiar difficulties of the vertical, is more accessible. The conditions under which this accessibility is obtained on shore are, however, very different from those on board ship. The arrangement, which is almost universal in horizontal gas engines, is for the exhaust valve to be placed at the bottom of the cylinder end, with the valve spindle pointing downward, and the distance from the center line of the crank shaft to the lowest point of the exhaust valve gear is considerable. This arrangement could not be applied on board a ship, for, apart from the undesirability of having an important part of the working mechanism down in the bilge, it would in most cases be impossible to raise the center line of the shaft sufficiently. The horizontal marine steam engines of the past were not so accessible as the vertical type which succeeded them, and they offered other disadvantages, notably in respect to ventilation. This was always difficult satisfactorily to arrange, as the radiating surfaces were low down with the working platforms above them, and the introduction of cool air to displace the hot impure air was from the nature of the case never efficient. This consideration applies with even greater force to the horizontal gas engine where, owing to the poisonous nature of the gas, efficient ventilation is an absolute necessity, and it would appear that for this reason alone a vertical type is essential for marine purposes, but much more experience is necessary with the vertical engine on shore before it can with reasonable certainty of success be applied to marine use in large units.

Many of the difficulties connected with gas engines are known to be a function of the size of the cylinder; below a certain diameter they do not exist, but they increase in magnitude and importance as this diameter is exceeded, and this feature, which is now universally recognized, has led many competent engineers to the view that it is better to accept an increase in the number of cylinders and limit their diameter rather than to court the troubles which lurk hidden in the larger sizes. How far this view will influence the development of the marine engine remains to be seen, and though the mind turns rather naturally against the idea of multiplicity of parts, we may in

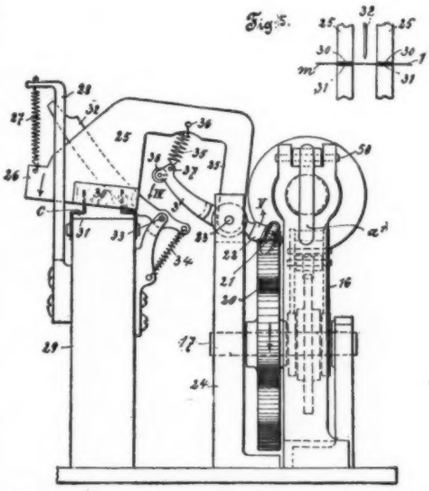
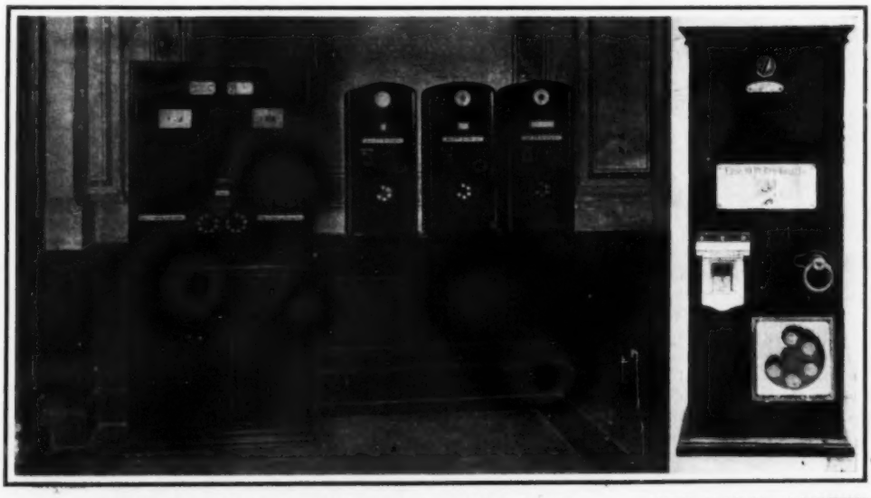


FIG. 4.—FRONT VIEW, SHOWING SEVERING MECHANISM.

time get used to it, and contemplate quite calmly an arrangement with twenty or more cylinders on one shaft. Mr. Yarrow has shown that with petrol engines a boat can be successfully run with twenty cylinders, though not all on one shaft, and our submarine boats from the A to C classes, inclusive, have sixteen cylinders capable of developing an aggregate of about 800 brake horse-power. Apart from the objection of multiplicity of parts, an increase of the number of cylinders has many advantages. The variation of turning moment is considerable in an engine having, say, four cylinders, and a fly-wheel is necessary to insure steady running. Further, with a gas engine the mean pressure cannot be reduced to any great extent without danger of miss-fires, owing to the mixture being too weak, hence large variation in speed is out of the question with few cylinders. To meet the requirements of a marine gas engine which shall compare favorably in control with our present steam engines, it would appear to be necessary to have a sufficient number of cylinders so that reduction in speed may be first obtained to a certain extent by reducing the strength of the mixture, and afterward by cutting out one or more cylinders; but the number of cylinders left in action at the slowest speed which may be required must be sufficient to give a reasonably uniform turning moment. Weight will be saved by an increase in the number of cylinders. This may appear paradoxical, but the reason is that the smaller the diameter of the cylinder the higher the speed of revolution at which the engine can be run. It is not always remembered, when reference is made to the extreme lightness which is obtained per horse-power in petrol engines, that this is not because they are internal-combustion engines, but on account of their extremely high speed of revolution. At the other end of the scale the large slow-running gas engines, using blast furnace or producer gas, where the mean pressure per square inch in the cylinders is not sensibly different from that obtained in petrol engines, the weight per horse-power is enormous. For the purpose of warships, where weight and space occupied are primary considerations, a large number of cylinders appears inevitable.

We have indicated some of the mechanical problems which await solution before the marine gas engine becomes a *fait accompli;* the thermal problems are not less difficult. Under this head may be included the design and working of the gas producers. Any marine engineer who has inspected a short installation of a gas plant designed for bituminous coal will at once realize that the very large space occupied by the apparatus for purifying the gas makes the adoption of such a plant impossible on board ship. With anthracite or coke the gas plant does not occupy excessive space, but probably no shipowner or naval authority would consent to be tied down to these fuels, especially in view of their limited supply as compared with steam coal. What is required is a gas producer which, without bulky or elaborate cleaning apparatus, can produce a gas satisfactory for the purpose from ordinary steam coal.

Enough has been said to indicate roughly the nature and extent of the problem which has to be faced in designing a marine gas plant of high power. Collectively, the difficulties with our present experience are formidable, but individually they should all be overcome by ordinary engineering skill and patient experiment. A celebrated American writer has observed that all our knowledge is an extension of the arithmetical formula $2+2=4$, and this remark exactly fits our question. When the various factors of the gas engine problem are more completely understood there will be little difficulty in adding them together. Meanwhile, W. Beardmore & Co., who engined the "Rattler" with suction gas engines, are to be congratulated, for though the published accounts of the results would seem to indicate that there are several points which require further attention—notably the reversing—the experiment marks a distinct step forward in the path of progress.—Engineer (London).



STAMP VENDORS INSTALLED IN BERLIN POST OFFICE. NEW MODEL, SHOWING INVERTED COIN.

CAN PRECIOUS STONES BE MANUFACTURED?*

THE CHEMISTRY OF GEMS.

BY STANLEY C. BAILEY, A.M.I.C.E., F.G.S.

NEARLY all the most precious stones used in jewelry are obtained from either metamorphic, igneous, or volcanic rocks and mineral veins. This shows that great heat and pressure, in conjunction with chemical action, are required to produce them. Some few owe their origin to the penetration of silicon, fluorine, and other elements into the fissures and cavities of rocks —for instance, the opal and the several varieties of chalcedony.

The fact that gems are scarce and sparsely disseminated in rocks goes to show that the conditions under which they were produced were probably abnormal.

Nevertheless, there seems to be no good reason why they should not be manufactured, knowing as we do the chemical constituents of the stones, and it would appear to be simply a matter for exhaustive research and experiment.

We have at our command now means of obtaining great heat with the electric furnace, in which we can attain to a temperature of 3,600 deg. C., which is sufficient to melt the hardest and most refractory materials.

Other lower flame temperatures which are available are given in the following table:

Coal	1,960 to 2,030 deg. C.
Crude petroleum	2,000 deg. C.
Coal gas	1,780 to 1,950 deg. C.
Hydrogen gas	1,960 deg. C.
Acetylene	1,900 to 1,920 deg. C.
Oxy-hydrogen gas	2,000 deg. C.
Carbon monoxide	2,100 deg. C.
Calcium carbide furnace	3,300 deg. C.

We can also obtain great pressures by the cooling and consequent contraction of masses of iron, or by means of the hydraulic press, with which pressures of from 7,500 to 8,400 pounds per square inch are common, while in laboratories hydrostatic force is utilized to exert pressures of from 10,000 atmospheres (65.6 tons per square inch) to 20,000 atmospheres (131.2 tons per square inch), for experiments on a small scale.

In 1880, crystals having the appearance of diamonds were made by Mr. Hannay by heating in an iron tube, under great pressure, a mixture of lithium (which melts at 180 deg. C.) and lampblack with essence of paraffin and bone oil.

Carbonado, or black diamonds, and minute crystals of transparent diamonds, were made in 1894 by M. Henri Moissan, the celebrated French chemist, by a process in which carbon obtained from sugar was dissolved in a mass of iron and allowed to crystallize out under a high pressure.

The carbon was strongly compressed in an iron cylinder which was closed with a screw stopper; then a quantity of soft iron was melted in a crucible in an electric furnace, and the cylinder was plunged into the molten iron. The crucible was then removed from the furnace, splashed with water, and allowed to cool slowly in the air. The mass of iron was eventually dissolved by repeated treatment with acids and reagents, which is a very slow process, but which leaves the diamond-like crystals intact.

M. Moissan produced, in 1894, silicide of carbon (CSi) in beautiful large crystals, very similar in appearance to sapphires, and considerably harder than rubies, by heating a mixture of carbon and silicon in the electric furnace, in the proportion of their atomic weights.

The crystals produced are most frequently yellow, but are quite transparent and colorless if the operation is performed rapidly in a closed carbon crucible, and provided the silicon employed is free from iron.

Sometimes the crystals are blue in color and closely resemble sapphires. They can be produced by four different methods, one of which is to distill the carbon and silicon at the high temperature of the electric arc—viz., 3,600 deg. C., the compound being formed by the union of the vapors of the two elements, the sublimation temperature of carbon being 3,500 deg. C. In the crucible, which is of pure carbon, a small block of silicon is placed, and after the base of the crucible has been exposed to the heat of the electric furnace, its interior is found to be covered with prismatic needles of carbon silicide in regular hexagons having a specific gravity of 3.12.

The heat of the electric furnace enables carbon to be volatilized, but, before volatilization, it is converted into pure plumbago, the sublimed carbon being always deposited under the form of graphite at ordinary pressures, and there is no evidence whatever of the liquefaction of the carbon, although under great pressures the carbon is fused, diamonds being then formed.

M. Moissan has also prepared chromium in large quantities by means of the electric furnace. Pure chromium has a specific gravity of 6.92 at 20 deg. C. It is practically unacted on in moist air, but burns at a temperature of 2,000 deg. C. in oxygen. It readily combines with silicon and carbon to form very hard compounds, and the silicide produced will scratch the ruby.

The artificial stone known as carborundum, which was first produced by Mr. E. G. Acheson in 1893, consists of carbon and silica, mixed in certain proportions, and exposed to the heat of the electric furnace. The resulting crystals of carbide of silicon (specific gravity 3.12) are of beautiful Prussian blue and violet colors with iridescence, and have a lenticular form. They can be manufactured at the rate of 150 pounds in a day of 24 hours, and the cost of production is only about half that of mining and preparing corundum.

In order to purify the crude material as it comes from the electric furnace, at a temperature of 3,500 deg. C., and after preliminary crushing to remove extraneous matter, the partially separated crystals are put into stone tanks and treated with dilute sulphuric acid, to remove all traces of iron, which is detrimental to the subsequent firing to which the product is subjected, and during its manufacture into grinding and emery wheels. It is so hard that it will scratch the ruby and soft diamonds, and, contrary to the general rule, it is a highly refractory substance, although a good conductor of heat.

A carbon of high fusing point and luminosity, for use in electric lamps, has been obtained by reducing to a fine powder pure carbon and carbide of silicon, and mixing them in the proportion of nine parts of the former to one of the latter, together with tar, or any other good binding materials. The mixture is then baked and molded into the proper form for use.

M. Leon Franck in 1896 showed that an appreciable quantity of carbon, in the form of distinct octahedral diamond-like crystals, is contained in all commercial pig iron and steel ingots. The iron is dissolved by nitric, hydrofluoric, and sulphuric acids, and the residue sinks in methyl iodide solution, showing that its density is above 3.0.

Prof. Miethe, of the Technical College at Charlottenburg, in Germany, claims that he has succeeded this year in making artificial sapphires, rubies, and emeralds, and also the rare gem known as alexandrite, and he is now engaged on processes for the manufacture of diamonds. The gems he has made can be produced at a remarkably low cost, rubies and sapphires ranging from 10 to 15 shillings a carat, and alexandrite costing about 50 shillings per carat.

In the accompanying table, which shows the approximate analyses of various precious stones, it will be observed to what a great extent silica and alumina enter into their composition.

	Rock Turquoise.	Precious Opal.	Precious Serpentine.	Jade.	Chrysolite.	Spinel Ruby.	Moonstone and Sunstone.	Garnet.	Rubellite.	Topaz.	Beryl.	Euclase.	Chrysoberyl.	Hyacinth.
Phosphoric acid	31.0	....	....	....	....	....	....	....	....	....	....	....	....	....
Alumina	44.5	....	...	21.0	0.2	69.0	19.0	20.0	44.0	57.0	19.0	32.6	80.0	....
Oxide of copper	3.5	....	....	....	....	....	....	....	....	....	....	....	....	....
Oxide of iron	2.0	....	....	....	....	....	....	....	....	....	....	....	....	....
Water	19.0	10.0	12.5	4.0	....	....	....	....	....	....	....	....	....	....
Silica	..	90.0	42.2	43.0	39.0	2.0	64.0	43.0	40.0	34.0	67.0	43.2	....	33.0
Magnesia	....	....	44.1	....	49.0	27.0	....	....	....	....	....	....	....	....
Protoxide of iron	....	....	0.2	2.0	11.5	1.0	....	33.0	....	....	....	....	....	....
Carbonic acid	....	....	1.0	....	....	....	....	....	....	....	....	....	....	....
Lime	...	....	....	26.0	....	....	....	....	....	....	....	....	....	....
Protoxide of manganese	....	....	....	1.0	....	....	....	4.0	....	....	....	....	....	....
Oxide of manganese	....	....	....	....	0.3	....	....	....	....	....	....	....	....	....
Chromic acid	....	....	....	....	....	1.0	....	....	....	....	....	....	....	....
Potash	....	....	....	....	....	....	17.0	....	1.3	....	....	....	....	....
Boracic acid	....	....	....	....	....	....	....	....	4.2	....	....	....	....	....
Lithia	....	...	....	....	....	....	....	....	2.5	....	....	....	....	....
Peroxide of manganese	....	....	....	....	....	....	....	....	5.0	....	....	....	....	....
Fluorine	....	....	....	....	....	....	....	....	....	9.0	....	....	....	....
Glucinum or beryllium	..	....	....	....	....	....	....	....	....	....	14.0	24.2	20.0	....
Zirconia	..	....	....	....	....	....	....	....	....	....	....	....	....	67.0
Loss	....	....	....	....	....	....	....	....	3.0	....	....	....	....	....

DIAMOND.

The diamond is pure crystallized carbon (specific gravity 3.5), and is supposed to have had a vegetable origin. It is generally found in alluvial material, and quartzose conglomerates, washed down by rivers from districts composed of igneous and metamorphic rocks. Diamonds of the first water are quite transparent, colorless, and free from flaws. The colored varieties may be either brown, yellow, orange, red, green, and blue, according to the impurities they contain. White and black specimens can also be obtained, but the red, green, and blue varieties are very scarce. The impure brownish-black varieties are known as "bort," or "boart," and are used (after they have been ground to a powder) for polishing precious stones. A hard, black variety of the diamond, called carbonado, from Brazil, is used for tipping or crowning drills for rock-boring, and also for glass-cutters. A circular saw, 7 feet 3 inches in diameter, with 200 diamonds on the periphery, was used during the construction of the Paris Exhibition, in 1898, for sawing stone. It was driven at 300 revolutions per minute.

TURQUOISE.

The rock or Oriental turquoise, also known as calaite (specific gravity 2.6 to 2.8), is usually found in crystalline rocks in opaque masses of a sky-blue or bluish-green color, due to the presence of salts of copper and iron. Occidental or bone turquoise, also called odontolite, is formed of the fossil bones or teeth of animals which have been colored with phosphates of iron or copper. Artificial specimens can be made by depositing finely-powdered ivory in a solution of copper, drying it, and then baking it slowly.

OPAL.

Precious or noble opal (specific gravity 2.0 to 2.1) is generally of a milky-white color, with a pearly, resinous luster, reflecting delicate tints like oil on water, of yellow, red, peacock green, blue, brown, and gray. Hyalite is the name given to the clear glassy variety. Fire opal or girasol reflects dark honey yellow, and bright hyacinth red or fire-red colors, and cacholong, or pearl opal, is of an opaque milky-white, or bluish-white color, and is usually found associated with chalcedony. Wood opal, which is petrified wood, is of a light-brown and milky-white color. Pink opal is of a crimson color, resin opal is a light yellow, and prase opal is one that is colored a light emerald green by oxide of nickel, while black opal is usually of a bluish-black or Prussian-blue tint, with emerald-green reflections. The opal obtained from Queensland is generally found in layers in ironstone and brown iron ore.

PRECIOUS SERPENTINE.

Precious or noble serpentine (specific gravity 2.5 to 2.6), which is sometimes used in jewelry, is a very beautiful stone of a rich oil-green color, and is translucent—that is, it transmits light—but is not transparent. It is found associated with serpentine, which is a metamorphic rock—that is, one which has undergone change through having become heated by contact with igneous rocks.

JADE.

Jade or nephrite (specific gravity 2.9 to 3.0) is compact actinolite, and consists chiefly of silica, alumina, and lime. It was well known to the ancient Greeks, Romans, and Egyptians, and is the rock out of which the Maoris of New Zealand, and other aboriginal tribes, fashion their stone charms, hatchets, and adzes. The Chinese carve images out of a very similar rock called prehnite. Jade is massive, tough, and compact, and is of a deep greenish to bluish, and pale whitish-blue color, and is easily cut.

* English Mechanic and World of Science.

CHRYSOLITE.

Chrysolite or olivine (specific gravity 3.3 to 3.5) is sometimes used as a gem. It is found in basalt and lavas, in independent crystals. It is transparent to translucent, and of an olive green, bottle glass, or yellowish-green color.

SAPPHIRE.

The sapphire (specific gravity 3.9 to 4.2) consists of pure alumina, and is generally found in the débris of metamorphic rocks, such as crystalline limestone, gneiss, mica slate, and talcose schist. It is transparent to translucent. True sapphires are blue in color, but there are several varieties of different colors, such as scarlet red, lemon yellow, light and dark green, violet, steel blue, and gray. They can also be obtained milky white and transparent. The red sapphire is the Oriental or true ruby, and is, next to the diamond, the most valuable of gems, as it is very scarce. Sapphires are known as Oriental topaz when lemon yellow, Oriental amethyst when violet or purple, Oriental emerald when green, and adamantine spar when of a brown color. When the crystals have a radiate chatoyant luster, they are known as asteria or asteriated sapphires; the bluish gray, steel color, or black crystals are called "emery," and corundum is the name given to dull gray and dingy-colored specimens.

RUBY.

The ruby, or spinel (specific gravity 3.5 to 3.6) occurs in metamorphic rocks such as gneiss and crystalline limestone, and also in volcanic rocks; in the ruby mines of Burmah, rubies are found associated with spinels and sapphires in a crystalline limestone. The colors vary from red, steel blue, green, yellow, violet, and brown to black. The scarlet-red spinel of pigeon's blood color is the common ruby of jewelry, the rose-red is known as the balas ruby, the orange-red and yellow as the rubicelle, or rubicel, the violet and purple as the almandine ruby, the green is the chlorospinel, and the black, which contains from 8 to 20 per cent of iron oxide, is called pleonaste, and is usually found in lavas. The magenta-colored ruby from Victoria (Australia) is called "barklyite."

MOONSTONE.

The moonstone (specific gravity 2.4 to 2.6) is an opalescent variety of adularia or white felspar, also known as orthoclase; it exhibits pearly reflections. Sunstone, or oligoclase, is very similar to moonstone, but contains minute scales of mica. Aventurine felspar, which is a light reddish stone, exhibits an iridescence which is due to small crystals of specular or titanic iron ore or limonite.

GARNET.

The garnet (specific gravity 3.5 to 4.3) is found in metamorphic rocks such as mica slate, hornblende slate, gneiss, and serpentine, also in granite and lavas. The colors vary from deep red to brown and green; white and black varieties are also found; the emerald-green color is due to chromium oxide. The rock ruby is a variety of garnet of a red color; pyrope or aluminium garnet is of a bright crimson tint, and precious garnet or almandine is of a clear, deep-red color, which is due to the presence of iron and aluminium; while cinnamon stone or essonite is of a light yellow, deep orange, and plum-red color with a high luster; it is also called hyacinth. Andradite is a calcium-iron-garnet of a transparent bright emerald-green color. Birds of the order of Rasores (scratching birds), such as the grouse and partridge, have a habit of swallowing any bright articles they may happen to come across, and garnets have been found in the crops of grouse which have been shot on moors where the superficial rock is granite.

RUBELLITE.

Rubellite (specific gravity 3.0 to 3.1), which is a pink or red tourmaline, is generally found in metamorphic rocks such as gneiss and mica slate, and also in granite and volcanic rocks. It has a vitreous or glassy luster, and the red, rose pink, yellow, brown, deep green, and steel-blue crystals are valuable as gems; the yellow specimens are sometimes passed off for topaz, the blue are called indicolite, the black are known as schorl, and the colorless as achroite.

TOPAZ.

The topaz (specific gravity 3.4 to 3.6) is found chiefly associated with granite and volcanic rocks. It has a vitreous and iridescent luster, the colors are pale yellow, deep yellow, orange, green, steel-blue, rose-red, violet, and it is also found white. Limpid transparent topaz pebbles are also known as gouttes-d'eau (drops of water). A rose-pink-colored topaz can be obtained by heating richly-colored yellow crystals. The Brazilian ruby is really a pale-red topaz, and the Siberian variety is white, or bluish white.

THE BERYL.

The beryl or emerald (specific gravity 2.65 to 2.75) has a vitreous luster, and is of a rich emerald-green color, which is due to the presence of chromium oxide; transparent, steel-blue, and lemon-yellow varieties are also found. The paler-colored varieties owe their tints to oxide of iron. The sea-green, olive-green, and pale bluish-green beryls are called aquamarines. Beryls are found in metamorphic and igneous rocks, such as dolomite, gneiss, and granite, and also in black carbonaceous limestone; the finest specimens have been found in dolomite, which is a coarse crystalline limestone.

EUCLASE.

Euclase (specific gravity 2.9 to 3.1) is not much used as a gem, on account of its brittleness; but it is a beautiful crystal of a pale-green color, with a vitreous luster.

CHRYSOBERYL.

The chrysoberyl (specific gravity 3.5 to 3.8) is found in granite; it has a vitreous iridescent luster, and the colors vary from an emerald green to Prussian green, also lemon-yellow, dark yellow, smoky brownish and smoky grayish-green. Alexandrite is a variety of chrysoberyl that exhibits emerald to Prussian green colors by daylight, which change to shades of red by yellow gaslight; the green colors being due to chromium oxide. This stone is found in the Ural Mountains, in Russia; but it is very scarce. Greenish yellow chrysoberyl is the Oriental chrysolite, and another variety is the true cat's-eye, known as cymophane.

HYACINTH.

The hyacinth, or jacinth, also called zircon (specific gravity 4.0 to 4.8), is the Matura diamond of Ceylon; it is found in metamorphic rocks, crystalline rocks, and lavas. The color varies from brown to red, orange, yellow, gray, and emerald green; white specimens are also found.

The name "hyacinth" is generally confined to the transparent red specimens, the clear crystals being much used in jewelry. The jargon, or jargoon, is a transparent variety with a smoky tinge, and comes from Ceylon.

ROCK CRYSTAL.

There are three varieties of quartz used as gems, viz., the silicious, the chalcedonic, and the jaspery. Of the silicious, rock crystal or white stone (specific gravity 2.6 to 2.7) is pure transparent silica or quartz; the crystals known as Brazilian pebbles are used for spectacle-glasses, and for lenses in optical instruments. Quartz rock crystals can be brilliantly colored artificially by introducing pigments into hair cracks produced by heating the crystals; they are then called "firestones."

AMETHYST.

The amethyst is a deep purple, or bluish-violet variety of quartz, found lining the cavities of rocks and mineral veins, especially copper lodes. The colors are due to the presence of oxide of manganese, which is also the cause of the violet and purple colors sometimes seen in window glass, after exposure for some time to the sun.

AVENTURINE QUARTZ.

Aventurine quartz consists of silica with inclosed minute crystals of golden yellow mica, the colors of which vary from brown to yellow, red, and gray; the artificial specimens are often more beautiful than the natural ones. Green aventurine quartz is of a beautiful leek-green color, and prase is also of a similar tint.

FALSE TOPAZ.

False topaz or citrine consists of pellucid silica crystals of a light yellow color, and the cairngorum or cairngorm stone of Scotland has a bright transparent yellow to a smoky yellow appearance.

CHALCEDONY.

Chalcedony, which generally occurs as a lining to the cavities, or "geodes," in rocks, is translucent, and has a waxy luster. Its color varies from pale and smoky gray to blue, green, light brown, red, and white. The green variety is known as "green earth," and comes from the Faroe Islands. Chalcedony is also found in blue cubical crystals, which are pseudomorphs—that is, they present a characteristic form, which is not their own, but of some other mineral, due to the decomposition and alteration of the original substance.

CHRYSOPRASE.

Chrysoprase is an apple or emerald-green-colored chalcedony, the colors of which are due to the presence of nickel.

CARNELIAN.

Carnelian is a bright-red chalcedony, but there are also orange-red and milky-white varieties. It is much used by the Japanese for beads. Sard is a chalcedony varying from a blood red to a brown color, and plasma is a dark green variety.

AGATE.

Agate is a variegated porous chalcedony, the colors of which are due to oxide of iron, and are arranged in thin concentric and zig-zag layers, or in brown, red, and white spots and blotches. When the layers are zig-zag, it is known as fortification agate. Mocha stone is of a transparent orange, yellow, brown, or milky-white color, with brown, black, red, or green, dendritic or tree and fern-like crystals inclosed, which are due to oxides of iron and manganese. Moss agate is transparent or light brown, with dark-greenish or dark-red markings, which have the appearance of seaweed and moss floating in water. Chrysoprase, carnelian, and agate can be artificially colored by iron oxide either a deep red, yellow, blue, brown, emerald green, or black.

ONYX.

Onyx is a variety of agate much used for cameos, the colors being arranged in alternate parallel layers of light brown and opaque white. When it consists of sard of a dull brownish red, or brownish-black color, and white chalcedony in layers, it is known as sardonyx.

CAT'S-EYE.

Cat's-eye is a translucent chalcedony of an olive greenish-gray color, with curious whitish internal reflections, like a streak of light, which changes its position as the stone is turned. This is due to the presence of fibers of asbestos. The true cat's-eye is really chrysoberyl. Tiger-eye quartz is of a dark-greenish or reddish color, and exhibits similar reflections to cat's-eye.

JASPER.

Jasper varies in color from dull red to yellow, and dark to light grayish green. It is a silicious rock, and consists of silica and clay, with yellow or red oxide of iron. Striped and ribbon jasper exhibits broad stripes of brown, red, gray, yellow, and green, and Egyptian jasper shows similar colors, arranged in irregular concentric layers.

BLOODSTONE.

Bloodstone or heliotrope consists of silica, clay, and oxide of iron. It is a dark-green stone containing spots of a bright-red blood color, due to the iron oxide, and is slightly translucent.

PASTEUR AND BACTERIOLOGY.

LOUIS PASTEUR laid the foundation for the study of disease-producing organisms; indeed, he may be said to have done more for the human race, more to prevent physical misery, than any other man of the nineteenth century. He had in mind, first of all, the cure, but he realized that to accomplish this the mode of transmission of the disease must be understood. There have followed him a long line of investigators of bacterial diseases, and among them the purely scientific have done quite as much as the purely practical. In Russia there was a celebrated embryologist, Elias Metchnikoff, who worked out the life histories of a variety of animals, and was thereby led to a consideration of the part that the white blood cells play in the development. This brought him to the view that such cells are the guardian policemen of the body, that seek out and destroy the bacteria; and this to the further idea, that health is to be maintained and infection prevented by keeping the white blood cells in proper numbers and activity. Metchnikoff succeeded Pasteur at Paris, and though his theory of phagocytosis is far from all-sufficient, it has nevertheless strongly stimulated the study of bacteriology. His practical ideas grew out of his theoretical investigations of insects and worms.

Just at the present time the center of interest in medicine is the study of those infectious diseases produced not by bacteria, but by other one-celled germs, the animal protozoa. Among them are the blood parasites that produce malaria, yellow fever, and the terrible sleeping sickness of Africa, as well as the intestinal parasites of bloody dysentery; another one of them produces the Texas fever of cattle. Many investigators have contributed to our knowledge of these diseases since the time when Laveran discovered the germ of malaria, and prominent among them are the names of Grassi and Schaudinn. Grassi is professor of zoology at Rome, well known for his researches on the ancestry of insects, on the social communities of the white ants and on comparative anatomy; these researches on unpractical subjects furnished him with the method for attacking the malarial germ, and for making the marshes around Rome nearly free from that disease. Schaudinn worked at Berlin on the life histories of salt-water protozoa, discovering much of broad theoretical importance, indeed with much greater success than the long line of naturalists before him. He was no physician, he was a biologist, yet he ultimately attained one of the most desired medical chairs in Germany. His genius, and in a measure he is to be compared with Pasteur, lay in his success in unraveling complex life histories; he learned the method in studying the free-living forms, and therefore was enabled to work out the life histories of several that endanger the human body. He never had any direct interest in practical medicine, yet what help his work has brought to medicine! What he did in this direction, the zoologists Leuckart and Leidy did in another by their discoveries on the parasitic worms of man, and on the mode of infection; they all had little thought of practical application. Such biologists have taught pathologists that in the cure of any infectious diseases the first thing to be determined is the life history of the parasite, and this subject is a biological one.—Popular Science Monthly.

THE PASSING OF THE WHALE.

THE ECONOMIC EFFECT OF EXTINCTION.

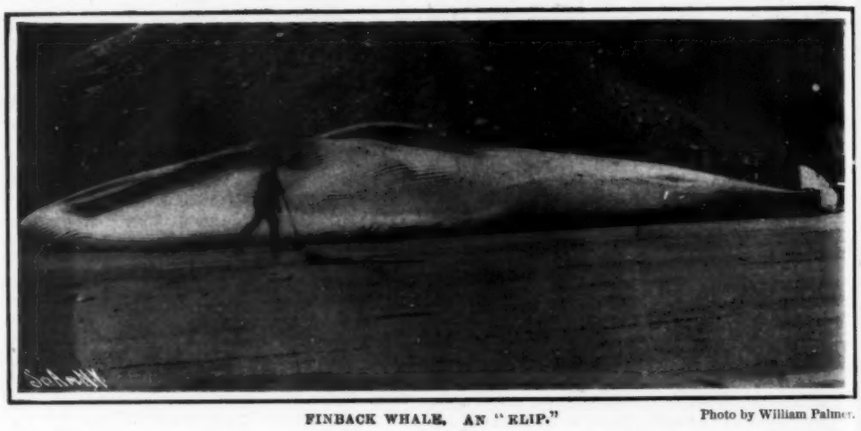
BY FREDERIC A. LUCAS.

Concluded from Front Page.

during the coming year. This will make seven factories in all, viz., Balena, Aquaforte, Snook's Arm, Chaleur Bay, Cape Broyle, Bonavista, and Trinity. In my opinion no further applications should be granted for some years. If licenses are given without restriction, it will result in complete depletion of this industry within a short time; while if judiciously dealt with, it will be a profitable source of revenue, and a great assistance to the laboring people of the colony for many years to come." This advice, however, was not heeded, the only restriction placed on whaling being that stations should not be nearer one another than twenty miles, and that but one steamer should be employed. These restrictions were practically of no avail, as one steamer was all that could then be employed to advantage, and a run of twenty miles is nothing to a 12-knot vessel. So whaling stations rapidly multiplied until by 1905 eighteen were in operation, occupying all the more favorable locations about Newfoundland, Labrador, and the Gulf of St. Lawrence, and fifteen steamers were employed. The effects of this over-multiplication were felt at once, and while in 1903 three steamers took 858 whales, or an average of 286 each, in 1905 fifteen steamers took but 892 whales, or an average of only 59 a vessel.

In 1903 3 vessels took	858 whales
In 1904 10 vessels took	1,275 whales
In 1905 15 vessels took	892 whales
In 1906 14 vessels took	429 whales
In 1907 14 vessels took	481 whales
	3,935 whales
Taken between 1898-1902, estimated	350 whales
	4,285 whales

Thus in ten years more than 4,000 whales have been captured in the immediate vicinity of Newfoundland. The effect was disastrous and caused ruin of the smaller companies, the chief sufferers being the smaller shareholders who had invested their entire capital.

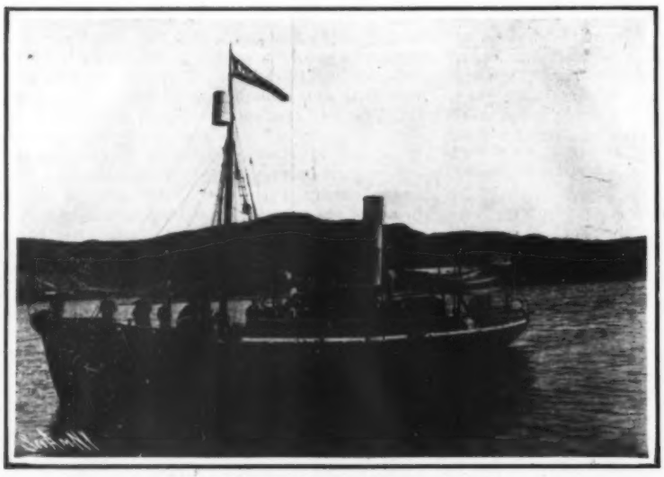


FINBACK WHALE, AN "KLIP." Photo by William Palmer.

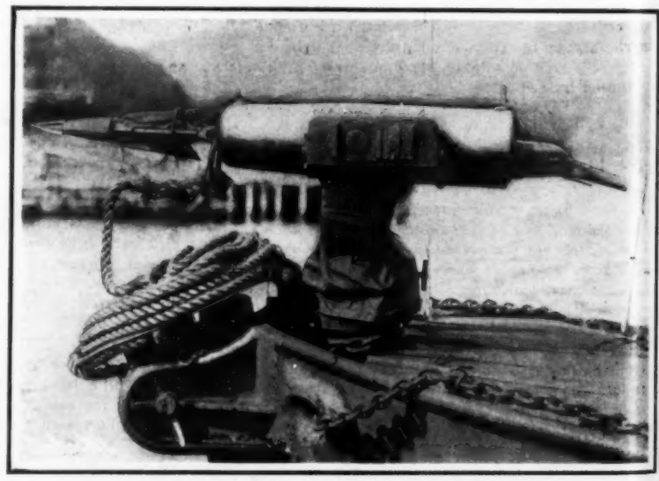
One of the arguments in favor of indiscriminate whaling has been the theory that whales had the whole world to draw upon and that the depletion in any one locality would soon be supplied by overflow from another. To a slight extent this may be true for there seems some reason to believe that whales do now and then pass from the Pacific to the Atlantic,* but on the whole whales are restricted in their range as other animals† and extermination in one place means extermination in that locality for all time. Another fallacy was the belief that the supply of whales was practically limitless and that one might "slay and slay and slay" continuously. There is not a more mischievous term than "inexhaustible supply,"

* Capt. Bull states that a sulphur-bottom whale shot on the coast of Norway contained a harpoon fired into it on the coast of Kamchatka, and that a humpback killed off Aquaforte was found to have in the flesh an unexploded bomb lance fired from a San Francisco whaler in the Pacific.

† For example, the sulphur-bottom is not found or occurs as a straggler on the east coast of Newfoundland, although once common on the south coast.



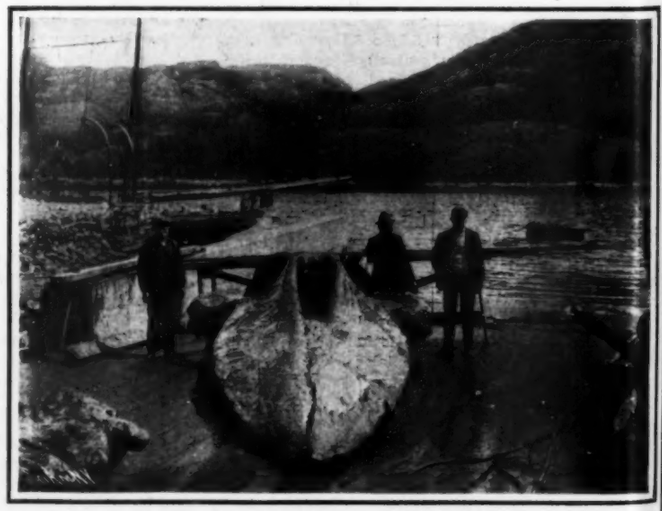
THE STEAM WHALER "ST. LAWRENCE."



NORWEGIAN HARPOON GUN READY FOR ACTION.

FINBACK WHALE READY FOR STRIPPING.

The hooks seen at the right are employed for turning the carcass over. Photo by William Palmer.



SKULL OF A SULPHUR-BOTTOM WHALE.

Length, 19 feet 8 inches. Weight, 8 tons. Photo by William Palmer.

and certainly none more untrue. So we see our inexhaustible forests on the verge of disappearing, our inexhaustible supplies of coal and oil daily growing less, and the end of the inexhaustible supply of whales in sight. Man is recklessly spending the capital nature has been centuries in accumulating and the time will come when his drafts will no longer be honored. It

FINBACK PARTLY STRIPPED AND READY FOR TURNING OVER. Photo by William Palmer.

matters not whether the vessel is a bucket or an ocean, one can only take out as much water as it contains, and where all is outgo and no income, it is merely a question of time when one or the other will be emptied.

The history of the Newfoundland whale fishery merely repeats what has taken place everywhere the whale has been hunted, the only difference being that owing to the limited area covered and the use of modern appliances results have been reached more quickly than in the days of sailing vessels and hand harpoons.

It is a matter of record how the right whale was successively swept from the Atlantic coasts of Europe and North America, then from the North Pacific and finally from the Southern Seas, and what has happened in the case of this species will happen in the case of others.* The great bowhead, owing to its restriction to a portion of the Arctic seas, and the ease with which it may be taken, is in a worse plight than his smaller relative and it is quite possible that the present generation will see its actual extermination.† And yet this monster once flourished in such numbers that for nearly three centuries its capture gave employment to hundreds of vessels and thousands of men. How abundant this species actually was we can only surmise from the former size of the whaling fleet and the statistics of its catch, though the old-time wood cuts showing the chase of the whale seem not to exaggerate its abundance. The American whaling fleet at the time of its greatest activity numbered from 500 to more than 600 sail, while in England, our most active competitor, from 25 to 60 vessels cleared from the port of Hull alone and several other towns contributed to swell the Arctic fleet which comprised from 150 to 250 vessels.

The imports of whalebone into the United States from 1805 to 1905 were 81,985,655 pounds. Averaging 2,000 pounds per whale, a rather high estimate, this would represent no less than 40,804 right and bowhead whales taken by American whalers.

Taking the port of Hull, England, we know partly by the actual returns and partly by estimates based on the yield of oil, that the ships of this port between 1722 and 1820, took in Davis Strait and on the east coast of Greenland no less than 10,207 whales, and a fair estimate of the total English catch would be about 20,000 right and bowhead whales, so that in two centuries not less than 50,000 were killed by English and American whalers alone.

But this is only a portion of the catch taken in the North, for as early as 1660 the Dutch sent 500 ships to the Spitzbergen fishery alone, and by the end of the century the number had risen to 2,000. Even though many of these were so small that nowadays they would be looked upon as mere boats, the total catch prior to 1750 must have amounted into the thousands.*

The contrast of these figures and the returns for the past two years show to what a low ebb the whales of this part of the world have been reduced, for in 1906 the catch of the Dundee fleet was but seven, and in 1907 only three whales were taken, one of these even being a yearling.

The catch of the San Francisco fleet was 20 in 1906, and 82 in 1907, but the success of the past year is the direct outcome of failure the year before, and the number of bowheads taken this year will undoubtedly be small.

Nothing can possibly prevent the extermination of the bowhead but the discovery of some perfect substitute for whalebone, and there seems not the slightest probability that this will be done, so that this huge creature will be one of the many victims immolated on the altar of fashion. Meanwhile it is worth noting that there is not a specimen of this whale in the United States and very few in the world and that some of the money being spent in futile endeavors to reach the North Pole might much better be devoted to chartering a whaler and securing one or two examples of the bowhead before it is too late.

The right whale was the first to be commercially exterminated, that is so reduced in numbers that its pursuit was no longer profitable, because it frequented the shores of temperate regions and there brought forth its young. It required but few years to wipe out the California gray whale, as it was confined to a comparatively small area and the decimation of the others is but a matter of time.

The great bowhead, as we have just seen, is on the verge of actual, not merely commercial, extermination and it is liable to be blotted out of existence at any time, and other species will follow unless something is done to preserve them.

For many years certain species of whales, notably the sulphur-bottom, enjoyed more or less immunity from pursuit, due to the difficulty of taking them by methods then in vogue and the small profit yielded when they were taken. But when the present appliances for taking whales were perfected the death knell of these whales was sounded, and unless some measures are taken to protect them, they, too, will suffer the fate of the bowhead.

Whaling stations are being established the world over wherever the conditions are favorable; there are several on the Pacific coast, several on the coast of Patagonia, and while, in deference to the fishermen, restrictions have been placed on the Norwegian whale fisheries, other stations have been opened in Iceland and the Faroes. There is some whaling from New Zealand and South Africa, and concessions have been granted for other parts of the world. This does not include whaling for sperm whales and humpback, carried on from various Atlantic and South American ports. Moreover, the rapid decline of the Newfoundland whale fishery has led some of the companies to send their steamers south in winter, accompanied by a large steamer fitted out for cutting in whales and trying out the oil, thus acting as a floating whaling station that may be moved from place to place as occasion requires or favorable conditions offer.

We speak of the *decline* of the whaling industry when it is really the *passing* of the whale, for there can be no industry in the proper sense of the word when there is no planting, only reaping, no attempt to provide for the harvest to be gathered.

Whales can be protected, and protected very easily, but it can only be done by international agreement. When we are far enough advanced, many industries like whaling and sealing, now on the verge of extermination, may be pursued for all time. This may be very difficult to bring about, but may be accomplished in time. The pity of it is, from a purely practical standpoint, that animals which can so readily be preserved should be swept out of existence.

In a letter to the SCIENTIFIC AMERICAN J. A. Mörch of Christiania, Norway, writes as follows:

"Whaling as it is practised to-day is not very different from whaling of thirty years ago. The appliances for catching the whales, the manner of extracting the oil from blubber, and the methods of converting the

* According to Wieland, the number of bowheads taken by the Dutch between 1669 and 1758 was 57,500.

STRIPPING A FINBACK. Photo by William Palmer.

THE PASSING OF THE WHALE.

* The writer is quite aware that this species still survives, and, owing to the cessation of whaling for some years, has even increased in some localities. This increase is now being taken, and in a year or two the species will again be at a low ebb.

† The possible extermination of the right and bowhead whales was foreseen as early as 1850, and comments made on the large number of whales lost by sinking and on the evil results of killing the right while on its breeding grounds.

meat and bones into marketable products are about the same. The most noticeable development in whaling at present is the employment of large old steamers as stationary floating factories in place of fixed permanent structures ashore. However, these floating factories as they are operated at present must of necessity form only a transition stage in the development of this manner of whaling. They are all fitted with appliances for working the blubber only; the carcasses are flensed lying alongside the vessel in the water, and after most of the blubber is removed the huge masses of meat and bones are left to drive before the wind and tide. Last season the catch from South Georgia, South Shetland, and the Falkland Islands amounted to about 40,000 barrels of oil divided among seven companies. The average yield of oil given up by one of the largest companies was about twenty-five barrels per whale. This means that about 1,600 carcasses were let adrift in one season! Mankind of to-day does not take kindly to wholesale waste of such proportions, and it must only be because the British government is uninformed about the matter that this state of things is allowed to pass on. No license ought to be issued to any company except under obligations that the carcasses be worked up. Quite recently a Norwegian company with a capital of about $250,000 was formed to carry on sealing and whaling around Kerguelen Island and it is the intention of the company to work up everything. The managers figure on a net profit of forty per cent on the capital invested, as based on the experience gained from an expedition to the same waters last year. And Kerguelen Island is just as far from the markets as is South Georgia.

"In the March number for this year of the Norwegian Fishing Gazette (Novak Fiskritidende, Bergen) the Gazette's regular correspondent upon whaling matters writes on the subject of floating factories:

"'The unfortunate condition of the whole affair is that the carcasses are so poorly utilized and that large values are wasted. The whole business must therefore be characterized only as a depredation which must mark only a transitory stage. When only half the value of an animal is utilized there must be something deficient and this must be remedied if the business shall be able to satisfy our economical sense.'

"The correspondent advocates full equipment of apparatus for utilizing the whole of the carcasses.

"All that is needed, however, is, as a strict condition for obtaining licenses, that the carcasses must be worked up. The rest is certain to follow of itself."

CATGUT FOR SURGERY.

HOW IT IS MANUFACTURED.

SPECIALLY prepared "catguts," or violin strings, are used by surgeons in making deep sutures and ligatures of blood vessels. The adoption of this material, which is due to Lister, marks a notable technical advance, for, as the catgut is ultimately absorbed by the tissues, the wound can be closed at once and even very large operative and other wounds heal "by first intention." In the old method, in which thread was employed, it was necessary to leave the wound open until the thread had become detached.

A good catgut must satisfy certain requirements of strength, flexibility, elasticity and, above all, asepsis, and these demands are fully met by the catgut now used in surgery. The preparation of crude catgut is very simple. The internal and external mucous coats of the small intestine of the sheep are scraped off, leaving only the intermediate muscular layer. This is then cut into strips which are converted into cords by gentle torsion and bleached by exposure to the fumes of sulphuric anhydride. The cords are next washed thoroughly with alkalies, stretched on racks and dried by a current of dry air. They are finally softened by beating them with a wooden mallet, polished with glass powder and sorted into arbitrary sizes, which are numbered from 000 to 6. After being tested for elasticity, flexibility, tensile strength and strength of knots, they are made up into skeins of two or three yards.

This crude catgut is totally unfit for use in surgery, as it contains microbes of many sorts, including *Bacillus subtilis, Micrococcus tetragenus, Staphylococcus pyrogenes aurens*, and even Koch's bacillus and the bacteria of anthrax if the intestines of diseased sheep have been employed in its manufacture. It is therefore sent to a sterilizing laboratory where it is first treated with ether, carbon bisulphide, or carbon tetrachloride, in order to remove the fatty substances and expose the germs to the action of the sterilizing process proper.

The various methods of sterilization which are or have been practised may be divided into the two classes of sterilization by chemicals and sterilization by heat. A simple method consists in immersing the cleaned catgut in strongly carbolated oil for a year. By this process the flexibility and elasticity of the catgut are preserved unimpaired, but some writers regard the sterilization thus effected as imperfect. Furthermore, the carbolated catgut is slippery and difficult to tie and it is absorbed very slowly by the tissues. The same objections may be made to catgut treated with chromic acid.

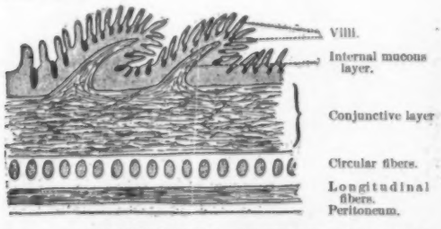


FIG. 1.—LONGITUDINAL SECTION OF SMALL INTESTINE.

The mercury treatment, when carried out in the usual manner by soaking the crude catgut for 24 or 36 hours in a 1 per cent solution of mercury bichloride in water and preserving it in a ½ per cent solution of mercury bichloride in alcohol, to which 10 per cent of neutral glycerine have been added, gives better but not perfect results. It is preferable to use the following process, recommended by Tripier, of Lyons: The cleaned catgut is soaked for 24 hours in a solution of 1 part of mercury bichloride in 1,000 parts of water, then immersed for 12 hours in absolute alcohol and finally preserved for use in boiled carbolated oil containing 5 per cent of carbolic acid.

In the Koercher process, which is used chiefly in Germany, the catgut is deprived of water by immersing it for three months in oil of juniper from which the excess of acid has been removed by neutral glycerine. The dehydrated catgut is preserved in a solution of 1 part of mercury bichloride in 1,000 parts of alcohol, containing 2 per cent of glycerine. Reverdin, of Genoa, however, claims to have obtained good cultures of microbes from catgut sterilized with oil of juniper.

FIG. 3.—A SMOOTH MUSCULAR FIBER GREATLY MAGNIFIED.

In short, no method of sterilization by chemicals appears to be free from objection, and consequently almost all surgeons prefer sterilization by heat. Reverdin was the first to employ dry steam at a temperature of 284 deg. F. In his process the catgut, after its grease has been removed by ether, is wound on small glass bobbins which are then placed in test tubes. The tubes are closed with plugs of roasted cotton wadding and placed in a Poupinel oven. The operation comprises two parts. At first the temperature is raised very slowly, attaining a maximum of 212 deg. F. in not less than one hour. The object of this first part of the process is to dry the catgut as thoroughly as possible. The temperature is then raised to 284 deg. F. and kept at this point for two or three hours. Six days later the entire double operation is repeated. After the tubes have cooled the cotton plugs are covered with sterilized India rubber caps which seal the tubes hermetically. This method is difficult to carry out in practice and a skilled operator is required in order to produce satisfactory results. If the first stage of the operation is conducted imperfectly, so that the catgut is not thoroughly desiccated, the residual water will convert the catgut into gelatine at the temperature of 284 deg. F.

Repin's process and the modified form of it recommended by Barthe and Soulard also require skilled and careful operators. In the Repin process the catgut, from which the grease has been removed by carbon bisulphide, is heated in the vapor of absolute alcohol, under pressure and a temperature of 284 deg. F. The bobbins of catgut are first heated slowly to 212 deg. F. in order to expel all moisture. They are then inclosed in glass tubes, two-thirds full of absolute alcohol, which are sealed by fusion in a flame and heated in an autoclave to 248 deg. F. for an hour. Repin recommends the preservation of the sterilized catgut in glass tubes filled with sterilized bouillon, which will give evidence, by turbidity, of the possible failure of the sterilizing operation. Barthe and Soulard reject this mode of preservation as both useless and dangerous and prefer to keep the sterilized catgut dry, in glass tubes sealed by fusion.

The alcohol process has been modified by several other surgeons. In all its forms it is open to objections of two sorts. The alcohol vapor diminishes the elasticity of the catgut, making it hard and brittle, and there is no absolute certainty of perfect sterilization. Grimbert has shown that certain germs, especially *Bacillus subtilis*, sometimes retain their vitality. His explanation is that the alcohol vapor hardens the surface of the catgut and thus opposes an obstacle to its own penetration into the interior, and in support of this view he cites an experiment in which he heated catgut to 248 deg. F. in alcohol colored with cosine. Only the surface of the catgut was stained by the dye; the interior remained colorless. In order to obtain thorough sterilization it is necessary to repeat the operation several times at intervals of 10 or 12 days; and this cannot be done without diminishing the firmness and strength of the catgut.

Consequently the alcohol process is being abandoned in favor of the new Beslier process, in which the catgut is heated in benzol under pressure. The Beslier process has been adopted by many surgical clinics in Germany, Austria, and Russia, and it is being adopted in France. The crude catgut is wound on glass bobbins and these are placed in a strong copper globe, half filled with benzol and closed by a copper screw plug. The globe is heated in an autoclave to 212 deg. F. for 25 minutes for the purpose of freeing the catgut from grease. The sterilization is effected in a second copper globe containing the bobbins inclosed in unstopped glass vessels. The globe is filled with benzol, closed with a screw plug, and heated in an autoclave to 248 deg. F. for an hour and a half. The plug is then removed, the benzol is siphoned off, the orifice is stopped with sterilized cotton, the residual benzol is evaporated over a water bath and the globe is filled with alcohol of a strength of 70 deg., in which the catgut is preserved for use.

Legueu has advantageously modified this process by heating the catgut one hour daily, for five successive days, to 248 deg. F. in benzol vapor, thus destroying all germs and notably *Bacillus subtilis*. In spite of Leguen's opinion, however, these repeated steriliza-

FIG. 2.—THE SMOOTH MUSCULAR FIBERS WHICH COMPOSE CATGUT, SEPARATED AND MAGNIFIED.

tions impair the flexibility, if not the strength, of the catgut, and this is an inconvenience of some importance. It would be better, therefore, to replace the benzol in Legueu's process by carbon tetrachloride. Experiments made by the writer have proved that this simple modification permits the realization of all the *desiderata* of modern surgery.

FRANCIS MARBE,
Director of Chemical Laboratory, Surgical Department,
St. Anne Hospital, Paris.

THE ASCENT OF SAP IN PLANTS.

A NEW AND INGENIOUS THEORY.

BY DR. GUSTAV GLOCK.

WHEN the chemist cannot determine the atomic structure of a new compound by analysis, he attempts to determine it by synthesis.

The mechanism by which sap is moved in plants has not yet been revealed by anatomical study, but we may, perhaps, discover it by constructing an artificial plant capable of performing at least this single function with the aid of the natural forces which are at the disposal of the real plant. At least two such natural sources of energy exist: variations in the temperature, and variations in the pressure, of the atmosphere.

The scheme of the artificial plant is shown in the illustration. It comprises an indefinite number of open vessels *b*, alternating in a vertical series, with closed vessels *a*. In the bottom of each closed vessel *a* is a small orifice *m*, which is covered by a valve opening upward and communicates with a tube *c* extending nearly to the bottom of the open vessel *b* beneath. The top of each closed vessel *a* is pierced by a tube *d* which extends downward nearly to the bottom of that vessel and terminates in a funnel-shaped expansion containing a valve *n* which opens upward. The tube *d* extends upward beyond the vessel *b*, above, and its curved end opens over the open mouth of that vessel.

Now let us fill the lowest of the open vessels *b* with water, and see what will happen. As the temperature falls, at night, the air in the closed vessel *a* next above, contracts, and "draws" water from the vessel *b* below, in which operation the valve *m* is open and the valve *n* is closed. As the temperature rises, in the morning, the air in *a* expands and forces water into the vessel *b* above, the valve *m* closing and the valve *n* opening automatically. This cycle of operations is repeated indefinitely. After all the vessels have been partly filled with water, they operate simultaneously, so that the water can be raised to any height. Hence a tree constructed on this plan would not be limited in height by any limit to the ascent of sap, but only by considerations of nutrition and resistance to the destroying force of the elements.

Variations in atmospheric pressure act in the same way. With a falling barometer the air in *a* expands and forces water into the vessel *b* above, and with a rising barometer the air in *a* contracts and "draws" water from the vessel *b* below, the valves opening and closing, as required, under the influence of the pressures in the various vessels.

This theory also explains the respiration of plants, which has hitherto been as puzzling as the ascent of sap. In animals, respiration is effected by the muscular contraction and expansion of the chest, and some equally powerful force is required for the circulation of air through the complex cellular structure of plants, in which simple "ventilation" is altogether inadequate. The apparatus described above works even better with gases than with liquids.

In our artificial plant we will, like Nature, make use of every force at our command. The device described will not work in the roots, where change of temperature and access of air are almost prevented by the soil, but the osmotic pressure, which is known, in this connection, as root pressure, is quite able to raise the sap through the roots and to a considerable height above the ground. Our device is superfluous, also, at the top of the tree, where the partial vacuum produced by diffusion and evaporation suffices for the last stage of elevation of the sap.

The capacity of the apparatus, computed in accordance with the laws of expansion of gases, is too small for the proper nourishment of the plant, if it is operated solely by the daily alternation in temperature. But the flow of sap in plants shows several periods of fluctuation in 24 hours, proving that there are other forces at work. Plants breathe, oxidize part of their food and, consequently, generate heat. If we assume that any vessel *a* in our apparatus contains, instead of water, root sap mixed with air and in process of oxidation, the heat generated in the vessel will force part of its contents into the vessel *b* above. After oxidation is completed the heated and expanded gases in the vessel *a* will cool and contract. Hence fresh sap will be drawn from the vessel *b*, beneath, and oxidation will recommence. The vessels *a* may therefore be regarded as simple heat engines, analogous to gasoline motors. When once started they continue to work independently of external changes in temperature, which serve only to start the machine after the winter rest or to keep it going slowly when fuel is lacking or oxidation is checked by cold.

Possibly the vessels, tubes, and valves of our machine may be represented by the intercellular spaces, tracheides, pore-canals and lenticels of the real plant. It is not to be supposed that sap is raised in one operation to the top of a California redwood tree, 450 feet in height, and the assumption that the sap is elevated gradually is in accordance with the necessity of depositing nourishment and the known occurrence of respiration, as proved by the presence of pore-canals, in all parts of the stem. But the strongest argument for the theory here sketched is the fact that it explains the ascent of sap as a result of the generation of heat by the plant, and consequently makes the plant independent of passing weather changes. Whether true or false it at least deprives the ascent of sap of all mystery by showing how it can be produced by natural causes.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

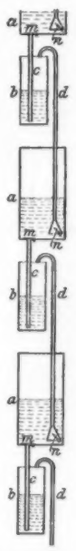


Diagram of an artificial plant, in which sap is gradually elevated to any height by fluctuations in temperature.

LODGING CONDITIONS IN PARIS AND OTHER FRENCH CITIES.

DR. J. BERTILLON has been led by his study of lodging conditions in cities to the conclusion that the cheap lodgings erected by the benevolent societies should be reserved for large families. There are three good reasons for this restriction. Large families are in greater distress than small ones, they are unable to obtain suitable lodgings in present conditions, and if the charity is restricted to large families it will cost less per capita, so that more good can be done with the same money.

Dr. Bertillon's careful and minute researches prove that it is quite impossible to give relief to all persons who are now improperly lodged. He makes a distinction between "insufficient" lodgings, which have more than one occupant per room, and "overpopulated" lodgings, with more than two occupants per room, and gives the following table for Paris, according to the census of 1901:

Overpopulated lodgings (more than 2 persons per room)	14.3 per cent
Insufficient lodgings (from 1 to 2 persons per room)	37.4 " "
Sufficient lodgings (1 person per room)	23.4 " "
Large lodgings (from 1 to 2 rooms per person)	19.7 " "
Very large lodgings (more than 2 rooms per person)	5.1 " "

Hence one-seventh of the inhabitants of Paris live three or more in one room, five or more in two rooms, seven or more in three rooms, etc. To give "sufficient" lodgings to the 340,000 persons who are now living in this deplorable state of overcrowding and promiscuity would require the expenditure of 1,000 francs ($200) per capita, or 340 million francs ($68,000,000) in all.

If the assistance is to be restricted to those who are most in need of it, the following table becomes of interest:

	No. of persons.	No. persons ill-lodged.	Per cent.
Families of 3 persons	527,000	72,000	or 13.6
Families of 4 or 5 persons	729,000	126,000	or 17.3
Families of 6 or 7 persons	282,000	93,000	or 32.9
Families of 8 to 15 persons	126,000	50,000	or 39.8

This table shows that the proportion of the ill-lodged increases rapidly with the size of the family, and that large families should be the first objects of benevolence.

Dr. Bertillon observes that the lodging problem varies in different sections of the city and that the rent paid by the ill-lodged in the heart of Paris would enable them to secure comfortable lodgings in the environs, which can now be quickly and cheaply reached by the Metropolitan underground railway. But even in the outlying sections there are more than 15,000 tenements, each of which is occupied by six or more persons. The first task, therefore, is to relieve these 108,000 persons, and this can be done for about 100 million francs ($20,000,000).

In many other cities the conditions are similar to those of Paris, as is shown by the following table:

Percentage of Ill-Lodged Families (More than Two Persons Per Room.)

Number in Family.	St. Étienne.	Dunkerque.	Cherbourg.	Reims.	Lyon.
3	24.5	19.4	25.1	8.6	23.6
4	20.3	15.2	17.4	5.8	11.3
5	69.7	53.1	49.9	42.0	21.8
6	69.1	53.3	48.8	41.3	5.7
7	73.9	67.2	57.8	59.8	35.6

From all this it appears evident that the cheap tenements erected by philanthropic societies should be reserved, at least for the present, for families with three or more children. This rule has been adopted by the Society l'Abri, which owns two large model tenement houses in Paris.—Revue d'Hygiène.

THE USE OF AFRICAN ELEPHANTS FOR TRANSPORT SERVICE.

EXPERIMENTS have recently been made in the basin of the Congo, to train elephants for transport service, for the question of transport appears to be one of the most difficult with which the Congo administration has to deal. The African elephant, heretofore of value only for his ivory, may in future contribute in no small measure to a solution of the problem in regions difficult of access by other means. The experiments which have been carried out, up to the present, show that elephants can be used to advantage for porterage work in regions where the opening up of the country is most difficult, because of lack of transportation facilities. Contrary to the general belief that Central African elephants could not be tamed, and made to perform the same service as their Asiatic fellows in India, a bulletin is stated by the American consul at Boma to have been issued by the Congo government, announcing the complete success of certain experiments conducted at an "elephant farm" at Api, in the Uele district, in the northern section of the Congo State. Here a small herd of young elephants has been found in captivity for several years, and finally after much effort in training them satisfactory results have been obtained. The director of the elephant station, in an official report, says that these experiments demonstrate that the African elephants can live in captivity, and that by good treatment they can be induced to perform labor. Already the oldest members of the elephant farm at Api execute the porterage and traction work of the station. They carry drivers on their backs, and pack saddles with loads. None of the animals is more than seven years old, and since the Indian elephants are most efficient at the adult age, 15 years, it is believed that even better results may be looked for. Mortality among the elephants newly captured has been great, and as yet it has not been possible to attempt to breed them in captivity, but experience is solving the problems of taming; the deaths are now few, and fresh recruits are constantly being added. With a beginning thus made the scope of the work at Api will doubtless be enlarged, and eventually it is expected elephant caravans will be established. Success in the undertaking means a great deal for the future of the country. Despite railways and steamship lines, the Congo will always be a country of forests and of savannas intersected with swamps. European stock does not survive in the tropical heat, and native carriers can be employed only to a certain extent. The elephant is

not affected by the tse-tse fly; it can ford the most steeply embanked and rapid streams, and, of still greater importance, it can cross the swamp lands encountered so frequently in the Upper Congo, and so often a barrier to men on foot. In establishing lines of communication to the regions so difficult of access, and to supplement the regular commercial routes, elephants may prove indispensable. They should be of even greater value to the white man penetrating Central Africa than in the jungles of Hindustan. Probably in no part of Africa are elephants found in greater number than in the basin of the Congo. Recoiling before the advance of civilization, herds which once thickly occupied all the humid countries of Central Africa, are now thinning or else gathering in regions inaccessible to hunters. They still range freely in many parts of the Congo, though not easily found near posts long established. White hunters must obtain, at a cost of $100, a permit for killing them as game, or for ivory, and the number allowed to be killed by each hunter is limited, as well as the time validity of the permit. Natives must also obtain permission to kill elephants. By these provisions, wholesale slaughter is in a measure checked, and the supply of ivory thus partially preserved. But for the permanent preservation of this source of wealth and of the species, the experiments in taming at Api also have their value. By closely studying the habits and characteristics of Central African elephants in the work at the Api farm, much information of scientific value about the comparatively little known Congo variety was obtained. In the region of vast plains cut by rivers and swampy streams of the Uele district the elephants thrive. They live especially in the marshy regions, feeding on the grass of the plains in the early morning, and returning to the shelter of near-by forests when the sun's rays grow warm. Rarely are the solitary "rogue" elephants met in the Congo. The African species are found generally in families, of three to six animals, but troops of 20, 30, or 100 are not rare, and witnesses even affirm that troops of several hundred exist. Shunning man, and as a rule fleeing at his approach, the African elephant when attacked often shows fight and is dangerous. Congo specimens have, to a marked degree, the characteristics which distinguish them from the Asiatic species. These, to outward appearance, are particularly the form of the skull and the very large ears. The latter even stretch back beyond the neck, and cover part of the flank. In color, the Congo elephants are of a grayish blue, almost of a slate-like tint. No one has ever reported seeing specimens of the sacred white elephant of India, in the Congo. As regards size, Congo elephants have been killed more than 14 feet high at the withers and reckoned at more than eight tons in weight. Tusks obtained are sometimes more than 200 pounds in weight and 6½ feet in length.—Journal of the Royal Society of Arts.

THE KÜCH QUARTZ MERCURY VAPOR LAMP.

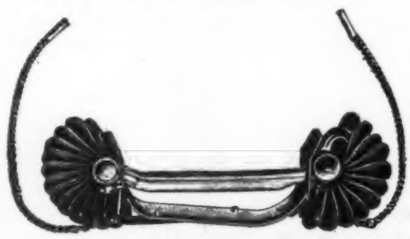
WHAT THE SUBSTITUTION OF QUARTZ FOR GLASS MEANS.

BY O. BECHSTEIN.

DR. RICHARD KÜCH has invented a mercury vapor lamp which appears to possess far greater practical utility than either the Arons or the Cooper Hewitt lamp. The applications of mercury vapor lamps have been restricted by the greenish-blue color of their light, their inconvenient form and size (the tube of a 110-volt lamp being 3 feet long) and their low economy in comparison with arc lamps, due to their comparatively low temperature, which could not be exceeded without melting the glass tube.

The tube of the Küch lamp is made of the molten quartz introduced into commerce by Dr. Küch a few years ago. Vessels made of this material not only resist extremely high temperatures without softening, but they do not crack when exposed to sudden and very great changes in temperature. The substitution of quartz for glass makes it possible to raise the temperature of the arc very greatly and thereby improve both the economical efficiency and the color of the light, in addition to diminishing the dimensions of the tube. The quartz tube bears a quartz bulb at each end. These bulbs serve as containers for the liquid mercury and the conducting wires are fused through their walls. Each bulb is surrounded by a fan-like radiator of sheet copper for the purpose of preventing overheating. As the tube is only about 3 inches long and ½ inch in diameter, it can be inclosed, with its radiators, in the globe of an ordinary arc lamp. The lamp is lighted and regulated automatically by a combination of electro-magnets, choking coils, and resistances contained in a housing above the globe. Without entering into the details of this apparatus, which is simple in action though rather complicated in appearance, it may suffice to explain that when the current is turned on its first effect is to energize an electro-magnet, which lifts the positive end of the mercury tube and causes a thin stream of mercury to flow along the tube and make connection with the negative pole. The strong current thus established energizes an electro-magnet in the tube circuit and thereby cuts out the shunt containing the tipping magnet. Thereupon the tube falls back to its original position, the mercury flows back into the positive bulb and, the metallic connection being thus broken, the mercury vapor arc is formed in the tube.

The temperature of the arc has been estimated by Dr. Küch at from 5,000 to 6,000 deg. C. (9,000 to 11,000 deg. F.). The temperatures produced by a series of low voltages in a lamp designed to operate at 180 volts were measured with a thermo-element. At 60 volts the temperature was about 1,700 deg. C. (about 3,000 deg. F.). This was the highest temperature that the thermo-element was capable of measuring, but as the temperature up to this point was found to be nearly proportional to the voltage, the temperature at 180 volts must be between 5,000 and 6,000 deg. C. if the law holds good up to that point. This high temperature develops a pressure of one atmosphere or more in the nearly exhausted tube, which shows a high vacuum when cold. Other mercury vapor lamps, similarly exhausted, develop a pressure of only about 1/12 inch of water when lighted. As the temperature and pressure in the quartz tube increase, the electric resistance and the difference of potential between its ends increases also. At first this difference is only 30 volts, the light is feeble and the arc fills the whole tube as it does in other mercury vapor lamps, but when the mercury bulbs have been thoroughly heated the arc takes its full voltage. This ranges from 85 to 95 volts in the 110-volt lamp and from 165 to 185 volts in the 220-volt lamp, the remainder of the voltage in each case being taken up by the resistance coils connected in series with the arc. The lamp then gives its full candle-power. The arc is contracted to a thread and is intensely bright, while the color of the light is no longer green-blue, but yellow-white.



QUARTZ TUBE WITH RADIATORS.

The efficiency of the new quartz lamp is very high, the consumption of energy being about ¼ watt per Hefner candle, when the energy is measured at the ends of the tube and the candle-power in a direction perpendicular to the tube. The following results were obtained in tests made at the Physikalisch-Technische Reichsanstalt.

Voltage between lamp terminals (without resistance)	174	197
Current, in amperes	4.2	4.2
Candle-power, perpendicular to tube	3,080	3,580
Candle-power, mean spherical	2,680	3,110
Watts per Hefner candle, perpendicular to tube	0.24	0.23
Watts per Hefner candle, mean spherical	0.27	0.27

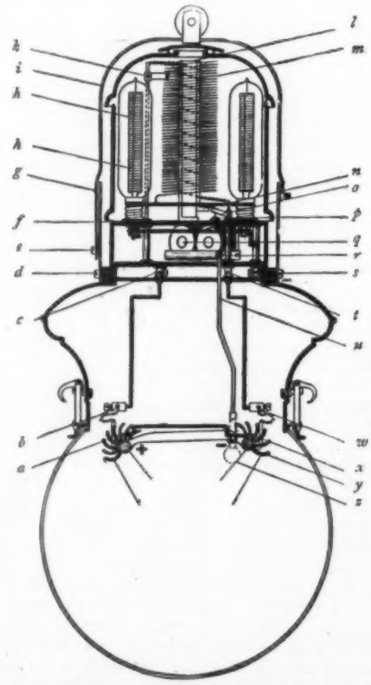


DIAGRAM OF QUARTZ LAMP.

In practice the economy is considerably diminished by the waste of energy in the resistance coils. The radiation is very rich in ultraviolet rays, which pass freely through the quartz tube. As these rays are injurious to the eyes and the skin, the luminous tube, if employed for direct illumination, must be surrounded by a dull glass globe. The globe absorbs luminous in addition to ultraviolet rays, and therefore causes a further diminution in candle-power, amounting to 5 or 10 per cent with matt globes, and 20 or 30 per cent with opal globes. But after all these reductions have been made the quartz lamp still far surpasses the older mercury vapor lamps and equals the best flaming arc lamps in luminous efficiency. It possesses several advantages over the arc lamp, the most important being its small cost of maintenance. It is warranted to burn 1,000 hours and during this period it requires no attention whatever. The lamp is made (by the Quarzlampen Gesellschaft m. b. H., of Pankow, near Berlin) in three sizes—3,000 and 1,500 candle-power for 220-volt circuits and 1,000 candle-power for 110-volt circuits. The lamps, with all accessories, cost from $40 to $50 each, and spent tubes can be exchanged for new on payment of $4. These high prices are due to the great cost of fused quartz, which is now nearly $7 per ounce, but will probably be reduced before long. The high cost of installation, however, is compensated by the economy of power and low cost of maintenance.

The new quartz lamps are excellently adapted to the illumination of streets and railway stations, and the intensity and peculiar color of their light makes them peculiarly valuable for advertising purposes. For large factory rooms and for indirect illumination of offices and drafting rooms they are also well suited. They are not well adapted for interior illumination in general, except in combination with other lamps, as their light, though of more agreeable color than that of the older mercury vapor lamps, is still deficient in yellow and red rays.—Prometheus.

A NEW THREE-COLOR CAMERA.

SIR W. DE W. ABNEY, K.C.B., F.R.S., exhibited and described before the recent meeting of the British Association for the Advancement of Science a new three-color camera of great ingenuity—a portable box of the usual dimensions. The point for the amateur, he said, was to be able to take three images on the same plate. When the plate was divided into three strips, and a special lens placed in front of each division, the lenses would be at different angles for the different plates, and stereoscopic effects would be introduced. He had hence adopted a central lens combined with reflectors for the three images, consisting of mirrors under 45 deg. and lenses. There might be a certain distortion in the side images relatively to the central image; that did not much matter for three-color work, for which the red and green were essential; the blue might be a little out of focus. But that camera was only suitable for a fixed focus; if we moved the screen, the two side images (red and blue) would not remain in focus with the central image (green). The arrangement finally adopted made all the second principal points at the same distance from the focusing screen, so that the focusing was equally correct with near objects for the three images. There were the central lens and three pairs of bi-concave and convex lenses in the camera exhibited, of 6 inches focal length. As regards the mirrors, Sir William considered varnished silver on glass too difficult to manipulate; such mirrors were so

good to travelers, he explained afterward to Prof. Worthington. He preferred metallic mirrors; speculum metal was too soft; polished planed steel, recommended by Vernon Boys, answered when fitted with screws and varnished with a solution of celluloid in acetone. There was loss of light, but he got 25 per cent of the available light. The camera only produced negatives with exposures of about 3 seconds, and he printed by a kind of Ives process.

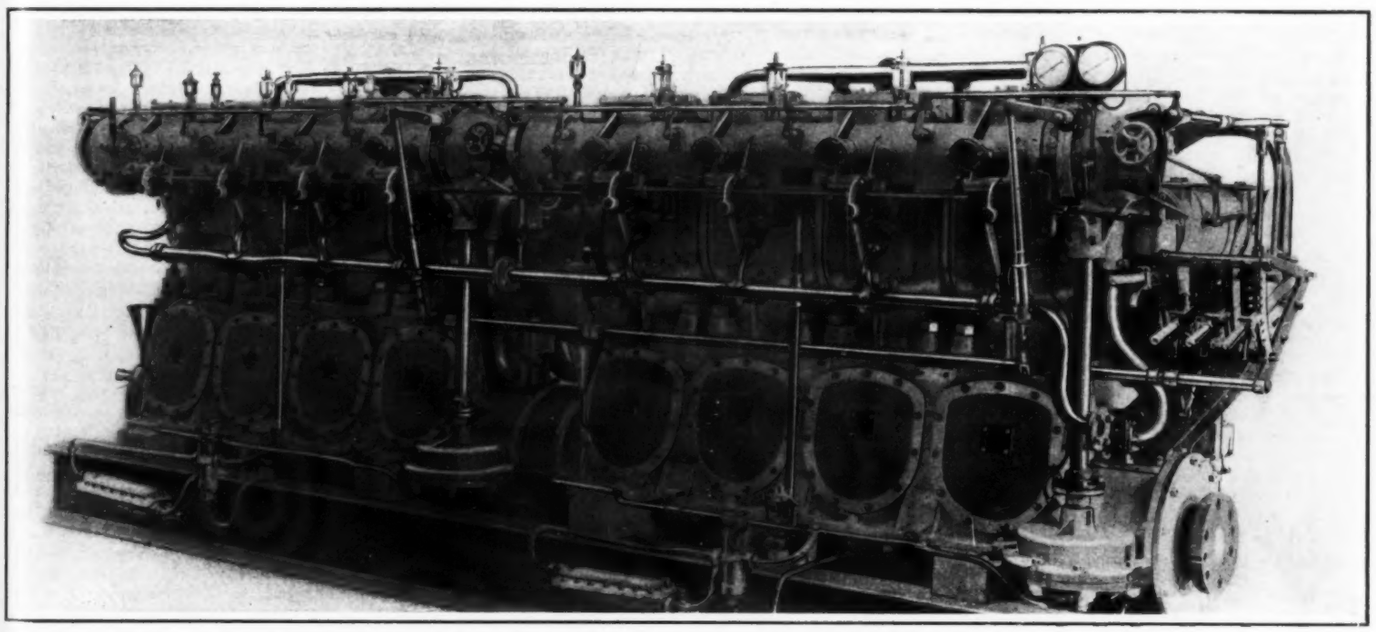
In the discussion, Dr. Harker drew attention to the remarkable reflecting power of the cobalt mirrors of Cowper-Coles. Dr. J. Milne, of Edinburgh, inquired about the application of the varnish, and Prof. Barrett, who occupied the chair, after congratulating Sir W. Abney on his recovery from illness, recommended mirrors of galena, which did not tarnish, and which Sir Howard Grubb (following Emerson Reynolds) had found very suitable for range-finders.

A 325-HORSE-POWER KEROSENE MOTOR.

THE ENGINES DESIGNED FOR THE ITALIAN SUBMARINES.

BY OUR ENGLISH CORRESPONDENT.

THE internal-combustion engines shown in the accompanying illustration are the largest yet designed for submarine boat propulsion. They are constructed for operation with kerosene fuel and are to be installed in two twin-screw submarine vessels that are in course of building for the Royal Italian navy. The engines were built by the well-known English warship builders, Sir John Thornycroft & Company. They are composed of two four-cylinder units bolted together as shown, making eight cylinders in all on each shaft. The cylinders have a bore of 12 inches by a stroke of 8 inches, and develop 325 B.H.P.



A 325-HORSE-POWER KEROSENE MOTOR FOR THE ITALIAN SUBMARINES.

The engines are totally inclosed, and lubrication is forced to all bearings. Special facilities for cooling have been incorporated, the crankshaft bearings as well as the bottom of the crankcase being water-cooled. Moreover, the pistons and crankcase generally are continuously cooled by means of cold air, which is drawn therethrough by means of an exhaust fan.

Special facilities are also provided for gaining access to the working parts. The pistons, together with their connecting rods, may be removed and replaced as required, through large inspection doors bolted to the front of the crankcase, so that release of the cylinder heads and withdrawal of the integral parts from the back of the motor are rendered unnecessary, which constitutes an advantageous feature in submarine-boat engine design.

The water circulation for cooling the cylinder jackets and so forth is effected by means of a separately driven centrifugal pump, operated either by an independent electric motor or a small oil motor using the same fuel as the main engine, according to whether the boat is running submerged or awash. A great advantage accruing from this arrangement is that the motor may be cooled more rapidly after running, in case an examination or adjustment of the machinery becomes necessary, since if the water circulation were driven off the main motor itself through gearing, this would naturally cease when the engine was stopped. The independent drive also allows of a close regulation of the quantity of water to meet the requirements of the engine, according to the nature of the fuel used.

A special type of kerosene vaporizer is employed having a variable exhaust bypass, so that the temperature requisite for the carburetion of the fuel may be exactly determined and graduated according to the density of the particular fuel used. This system is highly essential, since the oils adopted for fuel differ so greatly in specific gravity, and the amount of heat required to insure efficient vaporization varies so much that excess of heat is as harmful as insufficient heat. With a proper regulation of the heat, the engine or vaporizer never needs to be cleaned, because there is no resultant tar deposit. Consequently, trouble of this description is entirely non-existent with these motors.

An entirely novel feature has been incorporated in the reversing mechanism. Instead of the usual method of using a double set of cams for running in either direction, the camshaft is so arranged that, in whichever direction the engine itself runs, the camshaft revolves in one direction only, and to provide for this a reversible bevel drive with positive clutches is employed.

Starting in either direction is effected by means of compressed air, the valves controlling which are cut off as soon as the engine begins firing. The ignition is of the low-tension magneto type, with distributer fitted in conjunction with a special form of make-and-break gear in the cylinders.

The motor is very economical in running, the fuel consumption averaging approximately 0.7 pint of kerosene or gasoline per brake horse-power per hour. The engines are fitted with large bearing surfaces, and are in every way suitable for heavy continuous service, such as is required in a submarine craft. The total weight per four cylinders set is 7,840 pounds.

Before delivery the motor was submitted by the builders to a three hours' continuous trial upon kerosene of a specific gravity of 0.820, and the results achieved were as follows:

Time from start.	Revs.	B.H.P.
0 hours.	550	324
½ "	555	328
1 "	590	340
1½ "	595	327
2 "	595	318
2½ "	600	318
3 "	600	324

The revolutions thus averaged 582.5 per minute, giving an average of 325.5 brake horse-power with a fuel consumption of 0.66 pint per B.H.P. per hour.

The vessels which are to be propelled by this type of engine are 98 feet 6 inches in length by 14 feet 6 inches beam, displacing 150 tons. Propelled by twin screws, these submarines are designed for a radius of action over 500 miles at an average speed of 10 knots per hour.

THE NEW "VALVELESS" MOTOR.

INVENTORS and manufacturers alone know how difficult it is to successfully introduce new inventions and radical modifications in the design and construction of existing machines and apparatus. It is hard enough at times to depart from stereotyped practice, and only then is this done by the sheer force of universal requirements. When, however, a complete departure is made from what has become standard practice it is evident that nothing but the strongest reasons have induced the change, and it can generally be taken for granted that those who stand to gain or lose by the exchange have so far investigated the merits and feasibility of the innovation as to leave little doubt but that it will be superior in operation and successful financially.

The design of motor cars, their construction and working, and in particular the type of engine, have been looked upon as having reached the stage of standardization. This view has now received a huge shock by the appearance of the Knight high-speed internal-combustion motor, and which has been miscalled the "valveless" engine.

The general principle upon which this engine works has been known for some time, as it has been experimented with for several years in America. The chief feature of the engine, and the one that has been received with so much misgiving, is the provision of two concentric cylinders working between the piston and the cylinder proper, and which form the valves and passages for the ingress and egress of the mixture before and after the explosion by their relative movements.

These cylinders, with their openings, are as much valves as the D slide of the ordinary steam engine; the continuation of the cylindrical portion should be looked upon as an extension of the sliding or guide surface, the exigencies of the case tolerating its presence.

To some it would appear a retrograde step to revert

to any form of slide valve in view of its total disappearance in the gas engine before the advent of the gasoline motor. Also, the idea of a valve motion necessitating two large sliding sleeves would have, and doubtless has, been dismissed by many engineers on the score of being unmechanical in design and a failure in practice. A fortuitous combination of circumstances—a thing not usually met with—favored Mr. Knight in his design but these alone would have been of little avail without his indomitable energy and foresight.

There are many interesting features of the engine which we are here unable to touch upon, but one or two further points may be mentioned. Flexibility, as experienced in the ordinary type of petrol engine, has been considerably improved upon, the inventor attributing this to the spherical form of the explosive chamber. Again, the engine can stand a higher compression, and hence gives a greater power for its weight, and it also commands increased torque.—The Practical Engineer.

REMARKABLE INVENTION BY COWPER-COLES.

THE DIRECT PRODUCTION OF COPPER TUBES, SHEETS, AND WIRE.

SHERARD O. COWPER-COLES, when carrying out some experiments on the production of copper tubes and sheets by electro-deposition on rotating cathodes, observed that when the speed was greatly increased entirely new results were obtained, and that a current density of 200 amperes or more per square foot could be employed, the copper remaining smooth and having a tensile strength equal to the best rolled or drawn copper, and in some cases a tensile strength some 50 per cent higher than that obtained by the ordinary process of casting and rolling, the tensile strength increasing with the rate of rotation of the mandrel. The result of revolving a mandrel at a comparatively high speed is that every molecule, as it is deposited, is burnished or rubbed down so as to produce a tough fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper by rolling or drawing, instead of treating each molecule separately.

This observation led to further experiments, which resulted in evolving the process now known as the centrifugal copper process for the manufacture of sheets, tubes, and wire, which will now be described in detail, together with the results obtained.

After a long series of experiments had been made to determine the best composition for the electrolyte and the most economical current density to employ, the critical speed was accurately determined by means of revolving cathodes in the form of cones. By observing the point at which the copper remains smooth, and by measuring the circumference of the cone at that point and multiplying it by the number of rotations per minute, the critical speed is readily determined; 200 amperes per square foot is found to be the most economical current density, although a current density up to 500 amperes per square foot can be employed by increasing the rate of rotation, but the increased cost due to increased voltage renders such a current impracticable for ordinary commercial work.

One of the chief difficulties inherent in any electrolytic or wet process for the production of copper tubes and sheets is having any working parts, such as bearings, in an acid, copper sulphate solution, and this was one of the first troubles encountered when working the centrifugal process on a commercial scale. This difficulty was eventually overcome by constructing vats in the form of an annular ring.

One great advantage of the centrifugal process is that a very low voltage is required even when employing a very high current density; for instance, only 0.8 of a volt is required at the terminals.

The method of making tubes by the centrifugal process is as follows: A mandrel somewhat smaller than the finished internal diameter of the tube is prepared by coating it with an adhesive coating of copper by first depositing copper upon the surface from an alkaline solution and then thickening it up in an acid solution, the surface being highly burnished and treated chemically to insure the easy removal of the deposited tube. The mandrel thus prepared is then placed in a vat according to the diameter of the tube and its length. When the desired thickness has been obtained the mandrel is removed and placed in a horizontal or vertical lathe, and a round-faced roller run over the surface so as slightly to expand the deposited copper, which can then be readily drawn off.

Copper sheets are prepared in a similar manner, the only difference being that the mandrels are of much larger diameter, and a narrow insulating strip is fitted down one side so that the sheet can be easily removed by inserting a tool under one of the edges of the deposited copper. It is no more costly by the centrifugal process to make thin sheets than thick ones; copper foil can be made like the samples exhibited in five minutes direct from crude copper. Copper tubes produced by this process without any drawing have given a maximum stress of 17 tons, and tubes after drawing have withstood a pressure of 3,000 pounds per square inch without showing any signs of distress. Sheets made without any rolling have given a maximum stress of 28 to 30 tons and more per square inch, according to the peripheral speed at which the mandrels were revolved.

Copper pipes made by the centrifugal process have been subjected to hydraulic pressure, giving results far above those required by the London Board of Trade.

The formation of copper trees and nodules was another difficulty that had to be overcome, but which has been reduced to a minimum in the centrifugal process, for the reason that impurities held in suspension in the electrolyte have no opportunity of settling on the cathode, and all gas bubbles are swept from the surface on which the copper is being deposited.

The production of copper wire by electrolytic means is a more difficult problem than the production of copper tubes and sheets. Various processes have been suggested and tried from time to time, such as the electro-deposition of copper on thin wire, until it has obtained a considerable thickness, and then drawing the thickened wire down to a comparatively fine wire. Swan and Saunders have both experimented with such processes, but so far they have not been worked commercially. Ellmore's process consists in producing copper tubes by his burnishing process, cutting them into long spirals and then drawing them into wire.

Other experimenters have tried placing an insulated spiral strip on a cylindrical mandrel so as to produce long copper spirals, but such an arrangement only allows of a very low current density being employed, on account of the nodules which form on the edges of the strip, even at very low current densities, rendering the strip unsuitable for drawing down into wire.

Copper wire is made by the centrifugal process in the following manner: A mandrel similar to that used for making copper sheets is employed, around which a spiral scratch is made, the pitch being determined by the size of wire required.

The effect of the spiral scratch (which need only be very light but must be angular), is to cause the crystalline structure of the copper to form a cleavage plane. The copper divides exactly at the apex of the scratch, that is, the copper deposited in the scratch is equally divided and forms a small V-shaped fin on two sides of the copper strip. If the scratch is not angular, but rounded at the base, the copper will not divide, as the crystals are radial. After the desired thickness has been obtained, approximating the pitch of the spiral scratch, the mandrel is removed from the depositing cell and placed in a vertical position on a lathe, and the copper strip is unwound at an angle of about 45 deg. to the face of the mandrel. During the process of unwinding, the small fin or burr is removed by passing the wire through a suitable die and then through a wire-drawing machine provided with three or more draw-plates to reduce the strip to the desired diameter. By employing a mandrel of 6 or 7 feet in diameter, lengths of wire 4 or 5 miles long can be made in one operation.

The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolyzed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining.

The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least ten times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. There is no risk of lamination, as no burnishers are employed. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes. The process is of interest to mechanical engineers, as it conclusively proves that to get a high tensile strength in metals combined with ductility, it is not essential to put a large amount of work into the metals as hitherto has been considered necessary, by the processes of swaging, rolling, or drawing; a very small amount of energy will suffice.—Page's Weekly.

The Elektrotechnische Zeitschrift gives a few notes by M. C. Schapira on the efficiency of the high-frequency arc. The high-frequency arc burns between a hollow copper electrode, which is water-cooled, and a homogeneous carbon rod. A number of these arcs are usually burned in series, six burning on 220 and twelve on 440-volt circuits. Each lamp can be short-circuited independently of the others. The cooling water is heated to boiling point after fifteen or thirty minutes' run, and during work is kept at this constant temperature. The cooling water has to be renewed after about five hours' run. Measurements of energy consumption were undertaken and attempts were made to discover a law showing how the efficiency of the arrangement varied with the direct-current voltage, the number of arcs and the capacity of the oscillatory circuit. A new method whereby small capacity antennæ, or those with too great damping, can be indirectly set in oscillation is described. This is effected by connecting an auxiliary oscillatory circuit, whose wave-length is an exact multiple of that of the main circuit, in parallel with the latter and with the antennæ.

CŒUR D'ALENE DISTRICT, IDAHO.

THE Cœur d'Alene district of Idaho has in the last twenty-five years contributed to the metallic wealth of the country about $150,000,000. Of this total, about $100,000,000 was in lead, $45,000,000 in silver, and $5,000,000 in gold. A production of copper and zinc in the last two years is not included. But although the district has thus been for several years the greatest lead producer in the United States, comparatively little has been published concerning its geology. It lies in a region of rugged or densely forested mountains, very sparsely settled and poorly provided with roads and trails, and not until the beginning of the present decade was its mapping attempted. It had, however, been known to mining prospectors for twenty years previous, and indeed the story of the opening of the Cœur d'Alene region to mining enterprise may be dated back to the year 1842, when a mission was established by the Jesuits in the valley of St. Joseph River, a navigable stream which empties into the head of Cœur d'Alene Lake about five miles south of the mouth of Cœur d'Alene River. Between 1854 and 1863 a wagon road was built by Lieut. John Mullan over the Cœur d'Alene Mountains, connecting Fort Benton with Fort Walla Walla, and this highway, known as the "old Mullan road," was for many years the only line of travel into the region, to whose early development it substantially contributed. If it were not for the mines, however, the district would be nearly as complete a wilderness to-day as when the road was constructed, forty-five years ago. There is almost no arable land, and the timber, though good enough for mining purposes, would hardly have been sufficient inducement to bring railroads into the region. Mining is the paramount industry and on it all others depend. Approximately 4,000 men are employed in the mines and concentrating works, and the total population of the district is estimated at 8,000 to 10,000.

In 1900 and 1901 V. H. Manning, of the United States Geological Survey, made a survey of a quadrangular area lying on the western slope of the Cœur d'Alene Mountains, the results of which were published as the "Cœur d'Alene special map." This map formed the basis of geologic field work that was begun in the district by F. C. Calkins, of the Survey, in July, 1903. Mr. Calkins, assisted by W. A. Williams and D. F. McDonald, continued work in the field until October, 1903, and, with Mr. McDonald, resumed it in the summer of 1904, completing the geologic mapping of the area, while F. L. Ransome, the geologist in charge of the investigation, assisted by E. R. Zalinski, made a study of the lead-silver, copper, and gold ores.

A preliminary report on the results of this work was published in 1905, and the final report, unavoidably delayed by various causes, has just been issued by the Survey as Professional Paper 62. Part I of this report, by F. C. Calkins, treats of the general geology of the district; Part II, by F. L. Ransome, discusses the economic geology, giving details of the history of mining development and describing the mineralogy, geographic and geologic distribution, genesis, and development of ore deposits. It is profusely illustrated.

Concerning the future of the district Mr. Ransome says: "Few districts have shown greater steadiness in production in the past or give promise of more long-continued activity in the future. The pay shoots ex-

tend to great depths, with remarkably little change in the character of the ore. Some of the most productive mines are yet in their infancy, so far as deep workings go. The deeper Canyon Creek mines are apparently getting into lean ores and may cease to be profitable in a few years. On the other hand, new discoveries will undoubtedly be made in a district where such an ore body as that of the Hercules could so long remain unknown, and the total production of lead and silver is likely to increase for several years.

"In spite of the present activity it is not probable that the district will ever become prominent as a source of copper. The zinc output, however, is likely to grow larger, and may possibly attain considerable proportions."

WHITHER ARE WE DRIFTING?*

THE MOTION OF THE SOLAR SYSTEM THROUGH SPACE.

BY PROF. J. C. KAPTEYN.

SIR WILLIAM HERSCHEL was the first to show, though certainly his data were still hardly sufficient for the purpose, that the whole of the solar system is moving through space in the direction toward the constellation of Hercules. Later observations and computations have confirmed Herschel's conclusions, and we have even been able of late to fix with some precision the velocity of this motion, which amounts to 20 kilometers per second. This velocity is a 15,000th part of the velocity of light. In the 150 years elapsed since Bradley determined for the first time the position of numerous stars with modern precision, the solar system must thus have covered a distance of exactly a hundredth part of a light-year, i. e., we are thus enabled to make pictures of the sky as seen from points of view at a mutual distance of a hundredth of a light-year. Our eye-distance of sixteen light minutes is thus increased more than 300-fold. It appears that, for a considerable part of the stars, this distance, though not nearly so great as might be desired, is still in a certain way sufficient.

There is, however, a difficulty in the way, which prevents our pictures from giving a stereoscopic view of the stars at all, and thus prevents the determination of the distance of any star in this manner. The difficulty is that the changed directions in which, after the lapse of 150 years, we see the stars is not exclusively the consequence of the sun's motion through space, but is due also to a real motion of the stars themselves. The two causes of displacement which, in the case that we take the diameter of the earth's orbit as eye-distance, are separable by means of a simple device, become inseparable in the present case. In order to see whether this difficulty be or be not absolutely insuperable, let us take a parallel case on the earth.

At a certain distance we observe a cloud of insects hovering over a small pond. In order to evaluate the distance separating the insects from our eye, suppose that we make a photograph; then, after a few seconds, a second one from a slightly different standpoint. It must be evident that even if we have used an instrument which clearly shows the individual insects, the two pictures put in the stereoscope will not furnish a stereoscopic view of them individually; on the contrary, the picture as seen in the stereoscope will be perfectly chaotic. The reason, of course, is that in the interval between the taking of the two photographs the insects have moved. Does it follow that no evaluation of the distance can be obtained?

The answer must be, of any individual insect, no; but of the cloud, as a whole, we can evaluate its distance provided that the cloud, as a whole, has not moved; or, expressed more mathematically, provided that the center of gravity of the cloud has not moved, we can derive the average distance† of all the insects. We shall be sure of the immobility of the center of gravity if we know that the direction of the motions of the insects is quite at random; but this is by no means required. The motion may be preferably in a horizontal plane or along a determined line, say along the longer axis of the pond, provided only that the motions in any two opposite directions are equally frequent.

Not only that, even if the cloud, as a whole, is not immovable, we are not necessarily helpless. For, if the insect cloud and the photographer were both on a sailing vessel, circumstances would be the same as on the mainland, though now the cloud is in motion. Only, instead of the absolute displacement of the photographic apparatus, we must know the displacement relative to the ship, or rather relative to the insect-cloud. This, then, finally is the real thing wanted. We may obtain the distance of the insect-cloud, or, what comes to the same, the average distance of its members, as soon as we are able to find out the displacement of our point of view with regard to the center of gravity of the cloud.

Our case is much the same in the world of the stars. We shall be able to determine the average distance of the members of any arbitrary group of stars provided that we can find the motion of the solar system, both in amount and in direction, relative to the center of gravity of the group.

Now, astronomical observations such as those which led the elder Herschel to his discovery of the solar motion through space enable us to determine the direction of the sun's motion relative to such groups as the stars of the third, fourth, etc., magnitude. Spectroscopy enables us to determine the amount of that motion.

We must be able, therefore, to find out the average distance of the stars in these groups. For other groups, such as the stars having an apparent centennial motion of 10 sec., 20 sec., etc., there is a difficulty. Still, however, we have succeeded in overcoming this difficulty by a somewhat indirect process, and pressing into service the stars of which the individual distances are known. This, then, is the upshot of astronomical work on the distances.

* Abstracted from a paper read before the Royal Institution.

† The expression *average distance* ought, strictly speaking, to be replaced by the distance corresponding to the *average parallax*. For clearness sake I have ventured here and in what follows to substitute one expression for the other.

SUN SPOTS AND SOLAR TEMPERATURE.

PROF. E. T. WHITTAKER, F.R.S., the Royal Astronomer of Ireland, of Dunsink, near Dublin, read a paper on "Sun Spots and Solar Temperature" before the British Association for the Advancement of Science. The majority of astrophysicists, including Hale, he stated, now inclined to the view that sun spots were places of diminished (and not of increased) temperature. The view was based on the observational evidence: (1) that chemical compounds were present in spots; (2) that the characteristic "arc" lines were widened and the "spark" lines weakened in the spot spectrum as compared with the Fraunhofer spectrum; (3) that the continuous background of the spot spectrum had its maximum displaced toward the infra-red as compared with the continuous background of the ordinary Fraunhofer spectrum. Mr. Whittaker differed as to the interpretation of these observations: As to (1), the equations of Willard Gibbs showed that the dissociation of compounds depended both upon temperature and pressure, and that increased pressure would be just as effective as reduced temperature in favoring the existence of undissociated compounds; as now changes in temperature seemed to be less striking in the sun than changes in pressure, the argument taught us nothing about compounds. (2) Observations of the high-level and low-level chromosphere showed that the spark-lines *H* and *K* of calcium were favored by the conditions of the upper chromosphere, where both pressure and temperature were lower, and arc lines occurred more in the lower chromosphere, where pressure and temperature were high. The chromosphere seemed to be in more violent motion in its upper layers and the widening of the arc-lines really furnished evidence of increased pressure rather than of diminished temperature. (3) The difference between the continuous spectra of the spot and of the rest of the sun was analogous to the difference in the sunlight as observed at noon and at sunset; the rays of the setting sun had to traverse a greater amount of our atmosphere, the violet end of the spectrum suffered more absorption than the red, and (3) would indicate that the continuous rays from the photosphere passed through a denser intervening medium in spots than in the rest of the sun's surface. The three arguments all supported the hypothesis, therefore, that the sun-spot phenomena were to be ascribed to relatively high pressures rather than to relatively low temperature. Prof. J. Larmor, Sec. R.S., of Cambridge, remarked that, if he understood rightly, Prof. Whittaker considered radiation in bright lines as something abnormal, involving dissociation, and proceeded to read a paper on "The Zeeman Effect in Sun Spots." Prof. Hale, of the Mount Wilson Observatory, in California, had sent some photographs to Sir William Huggins, on whose behalf Prof. Larmor exhibited them. If the Zeeman effect shown by those photographs were verified, it was one of the most important discoveries in the history of sun spots. Zeeman himself, who had examined the photographs, was convinced of the reality of the effect. The photographs, we should remark, were taken with the tower telescope and the 30-foot spectrograph, a Fresnel rhomb and a Nicol prism being mounted in front of the slit. In a strong magnetic field each spectral line is —in the simplest case; the conditions may be more complicated—split into two rays circularly polarized in opposite directions. The Fresnel rhomb transforms the circular component vibrations of the doublet into two normal linear vibrations, and the Nicol will, according to its position, quench the one or the other line of the doublet. When the splitting up is not complete, the line will only appear widened and displaced; but whenever the effect is due to a magnetic field, the widening will shift from the right to the left of the line, as the Nivol is turned through 45 deg.

Without going into this explanation, Prof. Larmor said that the essence of the test was the relative quenching of the one or the other line or the shifting of the widening. The two photographs required an experienced eye for interpretation. Each of the pair showed the sun spot spectrum as a band crossing the sun disk spectrum, the latter spectrum appearing above and below the former. There was something abnormal or special in this sun spot spectrum; the Zeeman effect was only distinct in the red, not in the violet, end of the spectrum, and that might be due to the great depth of the turbid atmosphere from which the rays had been coming up. The question was whether the photographs really demonstrated the existence of a magnetic field. Zeeman believed they did. To account for the observed effect we wanted fields of enormous strength—5,000 C.G.S. units—and they were hard to explain. There might be whirls of positively and negatively-charged particles in the spots; but how were the particles separated? E. F. Nichols had in vain tried to separate them by centrifugal force. Why the earth was a magnet was not known; Kelvin had believed to the end that it was a rotation effect. A mere sliding of layers in sun spots could certainly not produce magnetism; Prof. Larmor thought it must be something molecular. Prof. Larmor then showed the third photograph, taken in hydrogen Ha light, which seemed to depict a hydrogen flocculus drawn into a spot vortex at amazing velocity.

A $500 PRIZE FOR A SIMPLE EXPLANATION OF THE FOURTH DIMENSION.

A FRIEND of the SCIENTIFIC AMERICAN, who desires to remain unknown, has paid into the hands of the publishers the sum of $500, which is to be awarded as a prize for the best popular explanation of the Fourth Dimension, the object being to set forth in an essay the meaning of the term so that the ordinary lay reader can understand it.

Competitors for the prize must comply with the following conditions:

1. No essay must be longer than 2,500 words.
2. The essays must be written as simply, lucidly, and non-technically as possible.
3. Each essay must be typewritten and identified with a pseudonym. The essay must be inclosed in a plain sealed envelope, bearing only the pseudonym. With the essay should be sent a second plain sealed envelope, also labeled with the pseudonym, and containing the name and address of the competitor. Both these envelopes should be sent to "Fourth Dimension Editor, SCIENTIFIC AMERICAN, 361 Broadway, New York, N. Y."
4. All essays must be in the office of the SCIENTIFIC AMERICAN by April 1, 1909.
5. The Editor of the SCIENTIFIC AMERICAN will retain the small sealed envelope containing the address of the competitor and forward the essays to a Board of Judges, who will select the prize-winning essay.
6. As soon as the Board of Judges have agreed upon the winning essay, they will notify the Editor, who will open the envelope bearing the proper pseudonym and containing the competitor's true name. The competitor will be notified by the Editor that he has won

the prize, and his essay will be published in the SCIENTIFIC AMERICAN.

7. The Editor reserves the right to publish in the columns of the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT three or four of the more meritorious essays, which in the opinion of the judges are worthy of honorable mention.

The Editor of the SCIENTIFIC AMERICAN is now engaged in selecting the judges who will award the prize. They will be three in number, and all will be eminent American mathematicians. The names of the judges will be announced in a later issue of this journal.

SCIENCE NOTES.

Two cottage buildings erected by the State of Illinois on the site of the Illinois Hospital for the Insane at Bartonville, at a cost of $100,000, and equipped with eight solariums for the work of phototherapy, were dedicated Thanksgiving Day. Two of the solariums are equipped in ruby, two in violet, two in amber, and two in opal. The incandescent lamps are of these colors, also the decorations on the walls.

In the Morris K. Jesup North Atlantic expedition it was found that in prehistoric times there was a distinct relation between the North American Indians and the tribes of Siberia. Dr. Waldemar Jochelsen recently started from New York to supplement the information at that time obtained. There are at present only about two thousand Aleuts in the Aleutian Islands, which belong to the United States, and in Komondorski, which is Russian territory. The race is rapidly dying out, and for that reason the investigations about to be made are considered of exceptional value.

The Preparation of Argon.—Fischer and Ringe have worked out a new method for producing argon from the air, which can be carried out on a relatively large scale at a moderate cost. The novel feature in the process consists in the use of calcium carbide for absorbing oxygen and nitrogen at a single step. This is used in the form of a powdered mixture of 90 per cent of calcium carbide and 10 per cent of calcium chloride heated in an iron vessel to 800 deg. C. The absorption of these gases is complete after sufficient circulation, practically with the formation of calcium oxide, carbon, and calcium cyanamide, according to the equations $O_2 + 2CaC_2 = 2CaO + 4C$, and $N_2 + CaC_2 = CN_2Ca + C$. The authors prepared eleven liters of atmospheric argon in the course of two days by means of their apparatus, and showed its purity by making determinations of its density. They make the statements that the atmospheric air contains 0.937 per cent by volume of "noble gases," the so-called crude argon; that the density of crude argon is 19.94 compared with oxygen as 16; that crude argon itself consists of 99.75 per cent by volume of argon, and 0.25 per cent of a mixture of helium, neon, krypton, and xenon, in which neon with the density 10 predominates, so that crude argon is somewhat lighter than pure argon, the density of which is 19.95.—Berichte.

Students of heredity are inclined to believe, on the basis of Mendel's experiments on hybridization, etc., that each individual characteristic of a species is represented by a definite determinant in the germ cell. As Loeb has expressed it, "this determinant may be a definite chemical compound. The transition or mutation from one form into another is therefore only possible through the addition or disappearance of one or more of the characteristics or determinants." Look where we will, such suggestions as these are ever before us. We may recognize to the fullest degree the value of the work which has been done, and is still being carried forward so successfully, on the chemical dynamics of physiological processes and the important bearing which the results thereby obtained have upon the problems we are now discussing, yet there is still before us the unanswered question, what are these specific determinants that are the carriers of heredity? If their individuality is bound up, as may well be believed, in the chemical structure of the protoplasm, what is the nature of the groups involved? What the character of the ions that are instrumental by their presence or absence in determining processes that are so fundamental in the perpetuation of species or in the production of modifications? Biological chemists may well work with enthusiasm on such a subject, and while it may be that one person's thoughts, for example, will lead him to a study of organic structure, another may be led with equal force to investigate the influence of positive and negative electrons on protoplasmic activity, each equally impressed with the value of his work in its possible bearing on the solution of the problem. Indeed, there is, I think, perfect assurance that both lines of work are called for if there are to be found positive answers for the many questions constantly arising relative to the subject of heredity and the transmission of specific characteristics. The problem is indeed intricate, or so appears at present, and we can only hope for success by following up every line of approach that presents itself.

ENGINEERING NOTES.

An investigation was recently made by Prof. J. Klaudy, for the Austrian government, on two reinforced concrete bridges, thirteen years old. In general, it was found that the infiltration of the gases of combustion from the locomotives had not extended deeper than 0.4 inch.

Cost of Oxy-Acetylene Welding and Cutting of Steel.—With oxygen at 3 cents per cubic foot, acetylene at 1 cent per cubic foot, and labor at 30 cents per hour, 30 feet of 1/16-inch metal can be welded per hour at a cost of 1.72 cents per lineal foot; 5 feet of ⅛-inch metal at 37.4 cents per lineal foot. Steel up to ⅛-inch in thickness can be cut at the rate of 60 feet per hour for 4.47 cents per lineal foot; 1½-inch thick and over at 49 feet per hour for 10 cents per lineal foot. These approximate figures are taken from a table in a paper by Augustine Davis, read before the International Acetylene Association, Chicago, August 11, 1908.

The underpinning of tunnels in soft material, in order to provide additional support and to prevent settlement or disturbance, is required only in very rare cases, but when it is required it calls for very special methods of treatment and is performed under difficulties. Such work, says the Engineering News, has been carried out at New York for one of the East River tunnels of the rapid transit railways, and is provided for in the Hudson River tunnels of the Pennsylvania Railroad. In both these cases, the tunnels are pairs of single-track iron-lined tubes, and the underpinning consists of piles which are either attached to the tunnel shell (as planned for the Hudson River tunnels) or carry transverse cradles (as at the East River tunnels).

It is claimed by leading English experts, according to the American Machinist, that the dredging since 1890 of the river Mersey and its approaches has been one of the most continuously successful undertakings of that character in the history of marine engineering. The Mersey docks and harbor boards some time ago placed an order for the construction of a dredger that will be the largest and most powerful ever built. The contract provides for a vessel that can lift 10,000 tons of sand in fifty minutes and attain a speed of 10 knots an hour. The propelling machinery will be of 3,500 indicated horse-power, and the dredger which is now nearing completion will have a hopper capacity of 180,000 cubic feet. Its dimensions will be as follows: Length 478 feet over all, 69 feet beam, and 30 feet 7 inches in molded depth.

The dredging of the harbor at Honolulu is being steadily proceeded with. The project being carried out is designed to provide an entrance channel 35 feet deep and 400 feet wide at mean low water, and to ease a curve at the junction of the entrance channel and the inner harbor by cutting off a projecting point. Further dredging of the harbor proper is contemplated with the view to providing a uniform depth of 35 feet and a general width of 1,200 feet at mean low water. The harbor proper has at present a general width of 900 feet, a length of about 300 feet, and a minimum depth of 35 feet. Hilo Bay, on the eastern side of the island, is practically an open roadstead, and the projected work is the construction of a breakwater at an estimated cost of $1,700,000. Pearl Harbor, eight miles west of Honolulu, consists of a series of deep-water locks some miles within the outer reef. Active measures are being taken by the United States with the view to making it an important naval station fully equipped with dry docks and the necessary plant for executing every description of ship repairs. The plan is to provide a waterway 37 feet in depth, at no point in which shall there be a curve of less than 2,000 feet radius.

Immediately after concrete and mortar are placed in a dam, the temperature of their mass rises and probably reaches a maximum in about 18 hours after the placing. This maximum is about 100 deg. F. for cyclopean masonry. About twelve months must elapse after the placing of masonry in the cross-section of a dam comparable with that at Boonton (55 feet base by 10 feet top by 90 feet average height) before the heat generated by the chemical changes incident to the setting of the cement becomes lost to an extent sufficient to render its existence a negligible quantity. Approximate computations indicate that the ultimate tensile strength of the mass of a masonry dam constructed of Portland cement is not far from 700 pounds per square inch. The value for temperature variation, according to distance from the face as arrived at by plotting thermophone readings, is approximately obtained from the equation $R = 135/3\,D^{0.333}$ where R is the total range of temperature, Fahrenheit, at any point in the mass, and D is the distance in feet to the nearest face of the dam. This is based on a total atmospheric range of 135 deg. F., from —18 deg. to +117 deg., and will not hold at low ranges of temperature. The formula, therefore, should not be considered as holding true for distances from the face of the masonry of more than 20 feet or less than 0.5 feet.—Thaddeus Merriman, in Proceedings Am. Soc. C. E.

TRADE NOTES AND FORMULÆ.

Waterproof Coloring Material for Roofs.—The production of a material for the water-tight covering of roofs and for similar purposes consists in repeatedly immersing wire gauze in linseed oil varnish or some other waterproof varnish or lacquer, allowing it to dry after each dipping, until all the meshes of the fabric are filled with the varnish.

Disinfectant paste is made of 100 parts of white bole, 1,000 parts of boiling distilled water, and 28 parts of ordinary nitric acid. This mixture is allowed to stand several days in a covered glass or porcelain vessel, but during this period it must be frequently stirred. The fluid is then pressed out and the clay is thoroughly washed out in a linen filter with distilled water and 5 parts of pulverized permanganate of potash added to it. This mass is shaped in molds, dried in a lukewarm place. The dried mass is wrapped in paraffined paper. In using it a little is scraped off and used as a wash powder.

Diamantine is a colored green powder for printing fabrics and the manufacture of artificial flowers. It is prepared by the preparation of chips of gum of the necessary size, then pouring over them in a dish sufficient solution of aniline color in alcohol to just cover them, heating the fluid to a gentle boil and allowing it to evaporate, while stirring gently. With the evaporation of the greater portion of the alcohol the fire must be increased, so that the last portion is transformed as quickly as possible into steam and escapes with considerable violence; by the last-named method a brilliant product is obtained. Frequently turning the dish, the grains are finally completely dried.

Paint for Roofing Paper.—I. Dissolve rosin in a hot mixture of a fat oil and coal tar, then add to this an intimate mixture of sulphide of barium and sulphide of zinc and coat the roof to be protected with the mixture. II. According to Roedelius 25 parts of distilled coal tar, 18 parts of distilled pine tar, 15 parts silicic acid, 10 parts magnesia, 6 parts linseed oil, 6 parts anthracene oil, 8 parts oxide of iron, 8 parts oxide of lead, 4 parts silicate of soda must be intimately mixed at about 212 deg. F., until a uniform mass is obtained. The mass, thinly applied, is transformed, within 12 hours, into a plastic cement, of gutta percha-like consistency, that is, in an extraordinary degree, weather proof.

Bleaching Oil.—This is intended for the preliminary treatment of paper and textile fabrics, in order to make the subsequent bleaching easier and cheaper. About 10 parts by weight of 100 per cent chloride of lime are dissolved in 100 parts of water; this solution is allowed to stand until it is perfectly clear, i. e., inasmuch as only the hyperchlorite of lime dissolves in water, until all that is insoluble has settled. Then we mix about 20 parts of this mixture with about 100 parts of dark, heaviest paraffine oil, or also heavy oil of tar, stir this mixture thoroughly together and allow it to settle. Hereupon the turbid oil is drawn off and of this 25 to 30 parts are mixed with 50 to 75 parts of the best, heaviest, distilled rosin oil, so-called medium oil. The raw substances, rags, etc., are boiled, in addition, with the customary media, such as lime, soda, etc., with this bleaching oil, according to the character of the material from 5 to 7 parts of bleaching oil being used with 1,000 parts of linen rags or cotton rags, 3 to 4 parts of bleaching oil to 1,000 parts of white cotton rags, 6 to 8 parts of bleaching oil to 1,000 parts of jute rags, 7 to 9 parts of bleaching oil to 1,000 of straw. After boiling, the goods are washed out cold and then bleached with chloride of lime. Substances so treated require much less time for bleaching and less chemicals; the saving in chloride of lime, especially, is considerable.

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